Expert Review on CTO PCI

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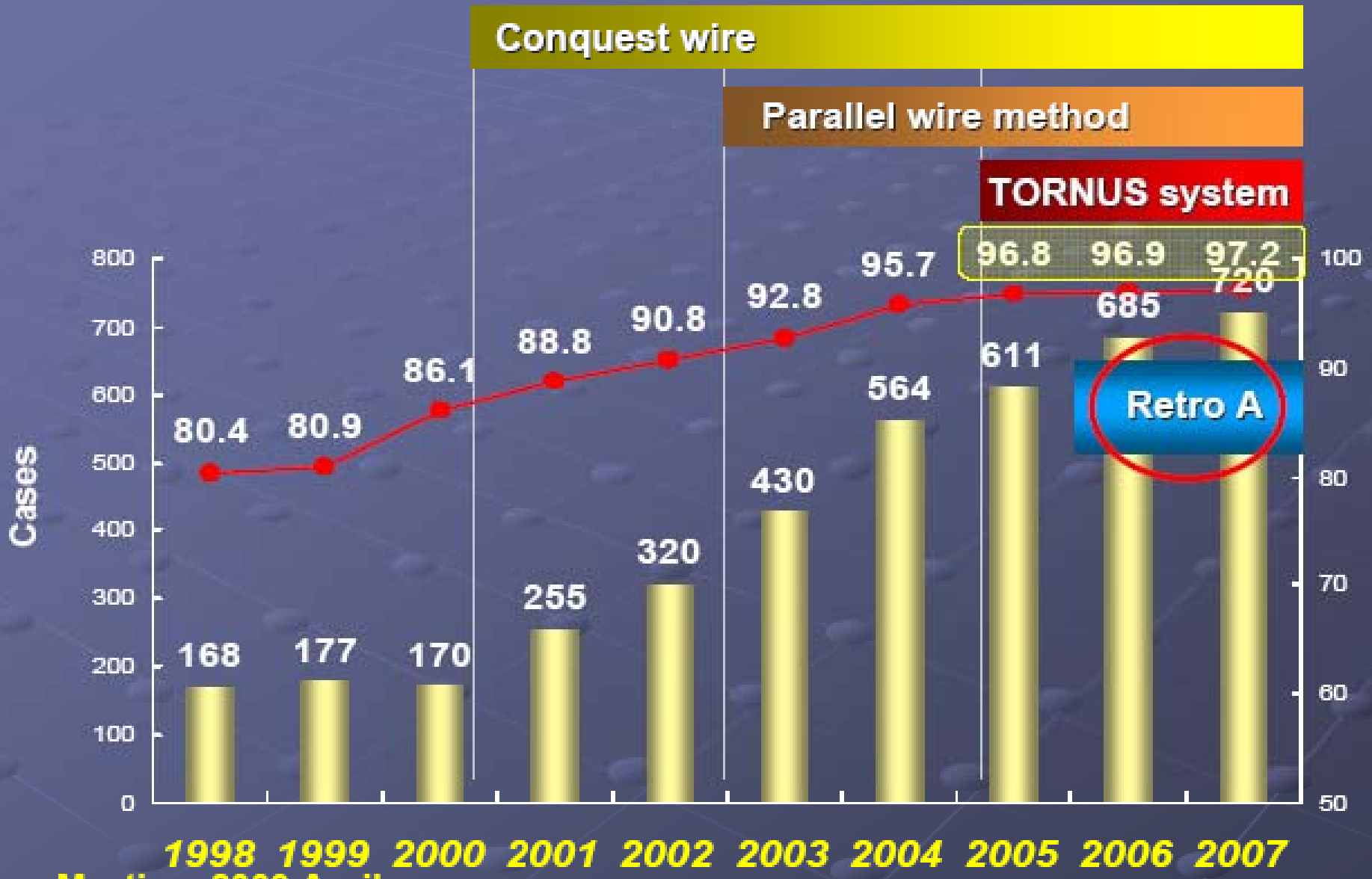
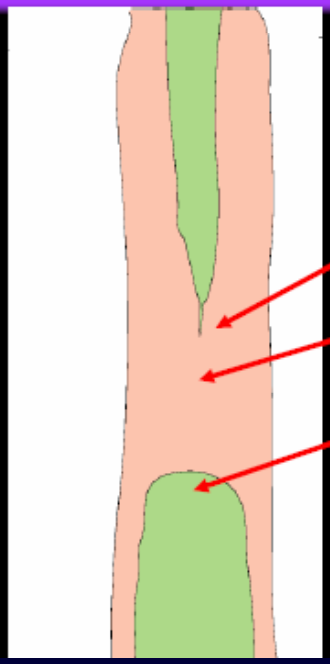
Changes of CTO Techniques and Success Rate



Asan Meeting 2009 April

“Easy” CTO vs. “Tough” CTO

“Easy” CTO



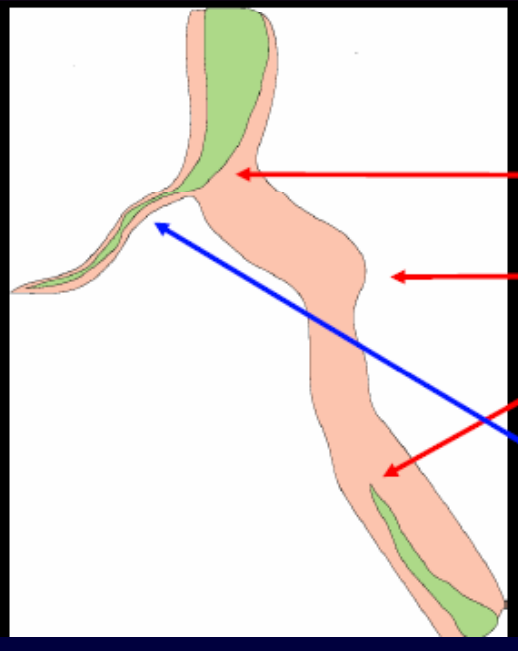
1) Straight vessel

2) Stump without side branch

3) Short lesion

4) Convex type

“Tough” CTO



1) Tortuous vessel

2) No stump with side branch

3) Long lesion

4) Tapered type

5) Small side branch where IVUS cannot be inserted

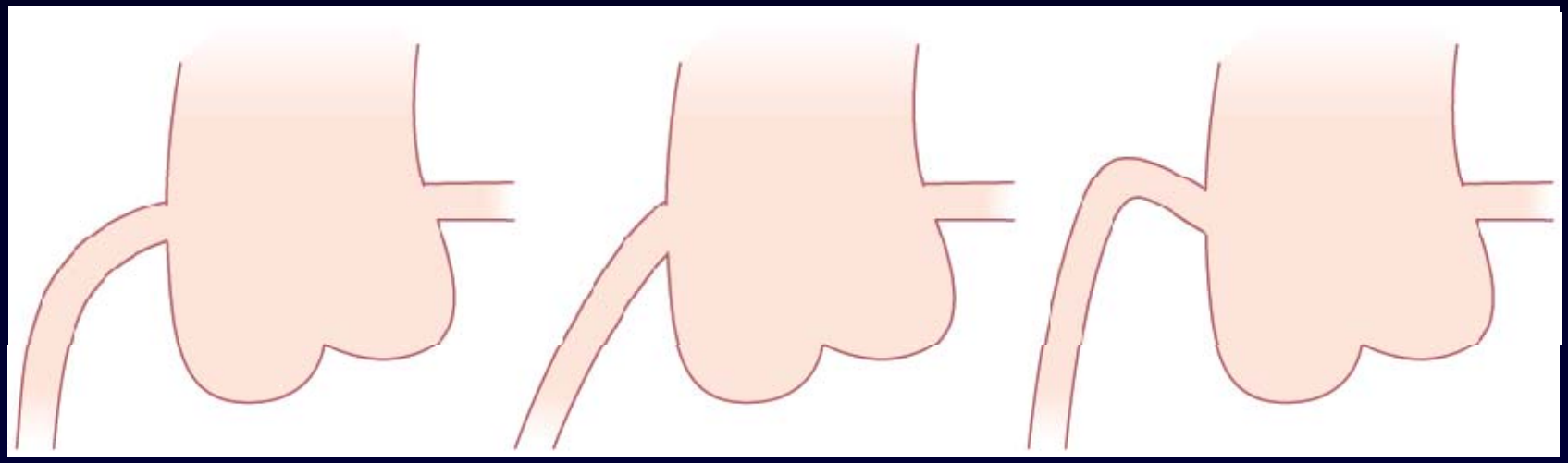
Usual guiding catheters in PCI of CTO

LAD : EBU (Medtronic)
XB, XBLAD (Cordis)

LCX : AL 1.0, 1.5
EBU 3.5, EBU 4.0 (Medtronic)
XB (Cordis)

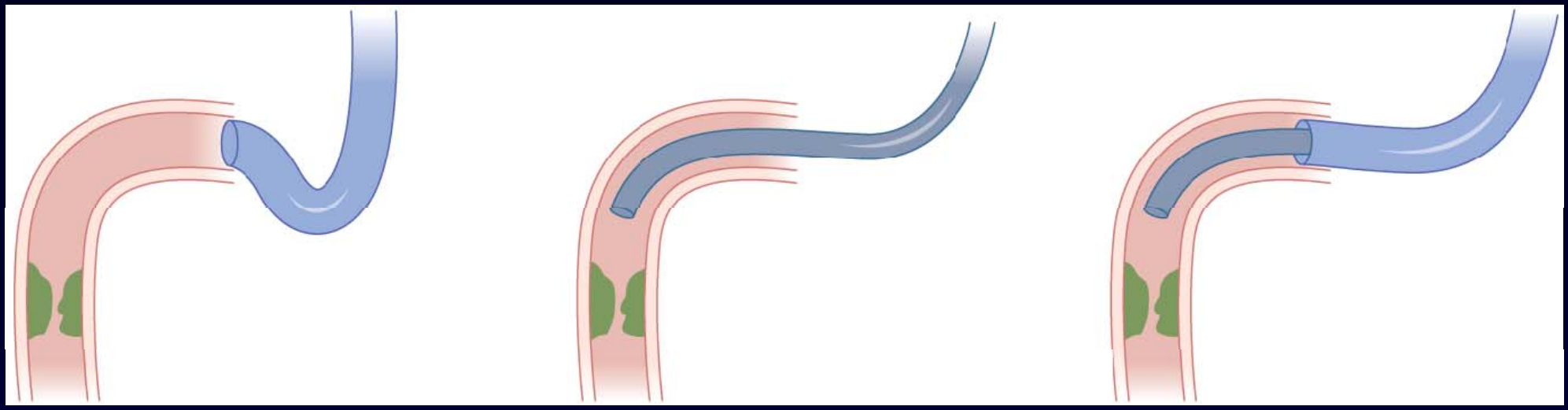
RCA : AL 0.75, 1.0
RBU (Medtronic)
XBRCA, XBR (Cordis)

Selection of guiding catheter for RCA according to the site of ostium



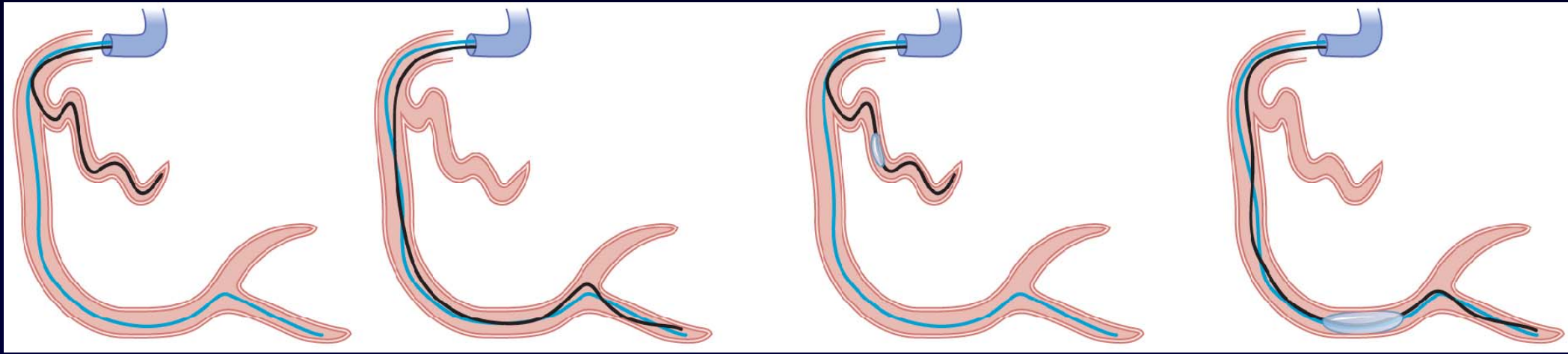
Normal	Downsloping (inferior)	Upsloping (superior)
JR 4, AL 1, AL 2 Multipurpose RBU (Medtronic) XBRCA, XBR (Cordis) Kiesz, All Right (Boston)	(inferior) JR 4, Multipurpose XBR (Cordis) All Right (Boston)	AL 1,2 Hockey-stick XBRCA (Cordis) All Right (Boston)

Catheter-Support Techniques



Passive Support	Active Support	Mother-Child Technique
Using large-diameter guiding catheter (usu. 7-8Fr with sie holes). A large left Amplatz sits at the ostium of the RCA	A 5 or 6F short tip Judkins right or multipurpose is deeply engaged the RCA	Dual coaxial guide catheter technique with a smaller inner (“Child”; 5, or 6F) inserted intracoronary via a larger (7, or 8F)guiding catheter

Hybrid techniques of guiding catheter stabilization – Anchor wire / balloon techniques



A: “Anchor” wire in atrial branch of the RCA proximal to the lesion

B: “Buddy” wire in the posterior descending artery (PDA) distal to the lesion

C: “Anchoring balloon” in atrial branch of the RCA proximal to the lesion

D: “Anchoring balloon” inflated in the distal third segment of the RCA.

Wiring Strategy
Proposed by the Japanese Operators

Pre-procedural Examination of Angiogram w/wo MSCT

Antegrade approach

1. Single wire manipulation
2. Parallel wiring
3. IVUS guided wiring

Retrograde approach

1. Wiring through collateral
2. Retrograde wiring
   - Retrograde wire crossing
   - Kissing wire technique
   - Knuckle wire technique
   - CART
   - Reverse CART

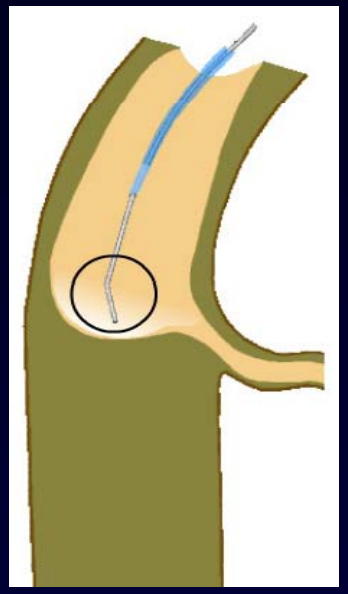
During the wire handling,

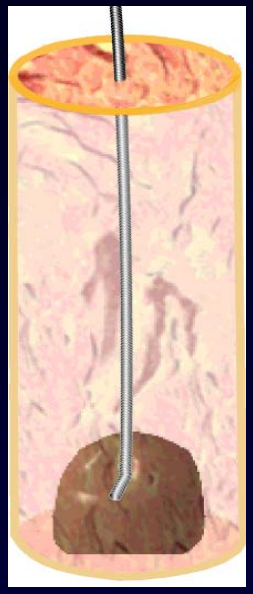
- Pay attention to the feel of wire tip against the lesion by push and occasional pullback,

  1. To keep the true channel
  2. Not to slip it into the false channel
  3. To change the wire appropriately

- Never advance it fast, and never rotate it rough!

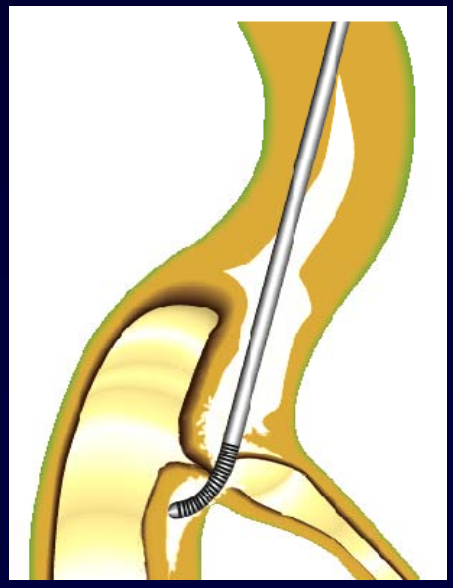
Special shaping of the wire tip



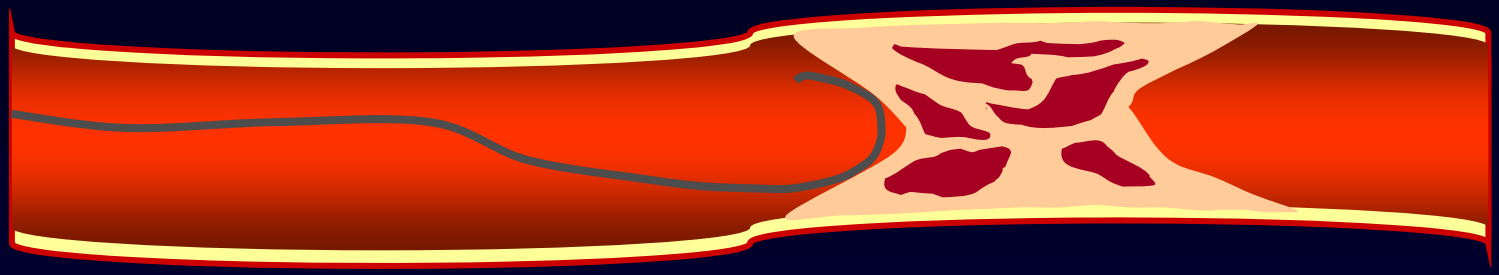


Penetration of proximal or distal fibrous cap

Penetration from subintimal space

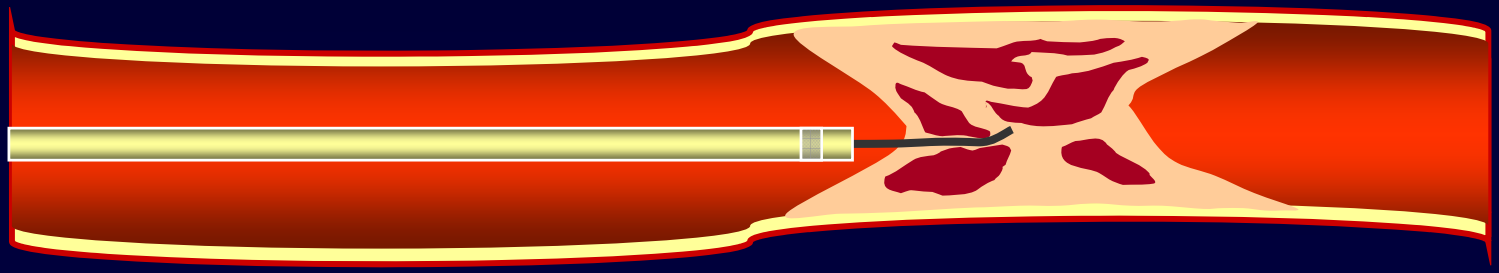


Wire only



The tip of the guidewire often curves back at the proximal fibrous cap due to poor backup support.

Wire with Micro-catheter



Micro-catheter reinforces torque transmission of guidewire and creates better backup support for penetration of the complex lesion.

Single Wire Manipulation - 1

- Your favorite soft wire should be used to advance the support catheter ahead of CTO.

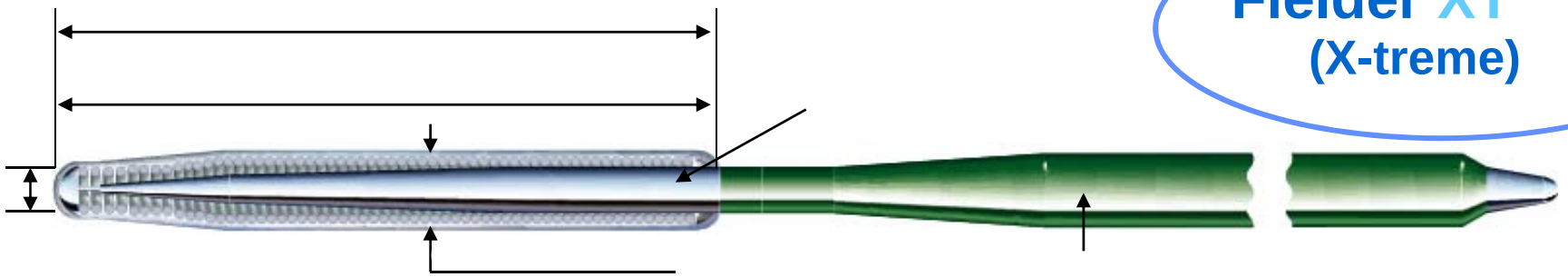
- Recent occlusion without bend in CTO

  → Any soft wire

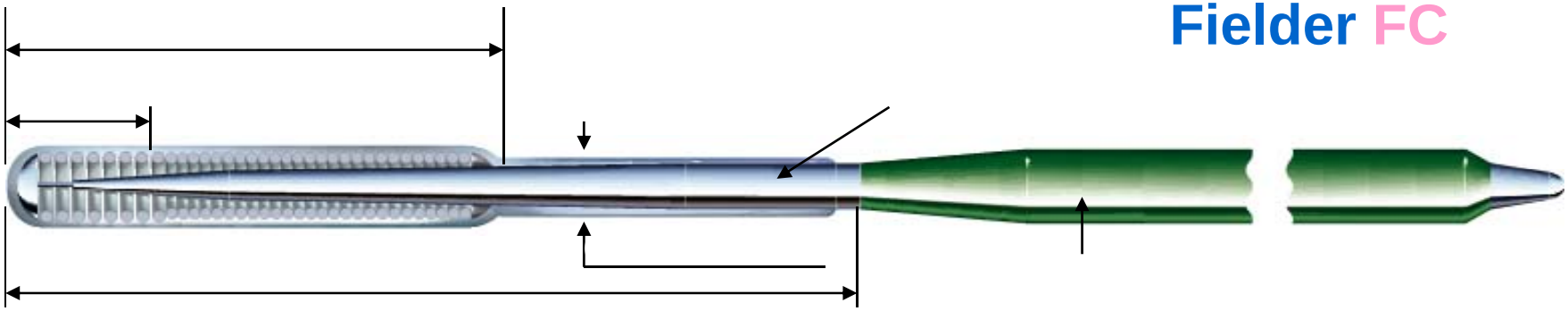
- Recent occlusion with bend in CTO

  → Hydrophilic soft wire

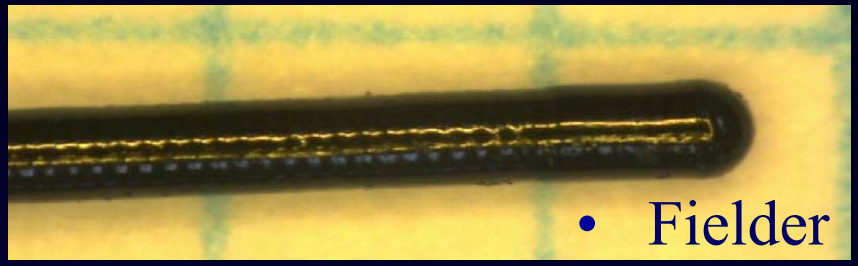
Fielder XT (X-treme)



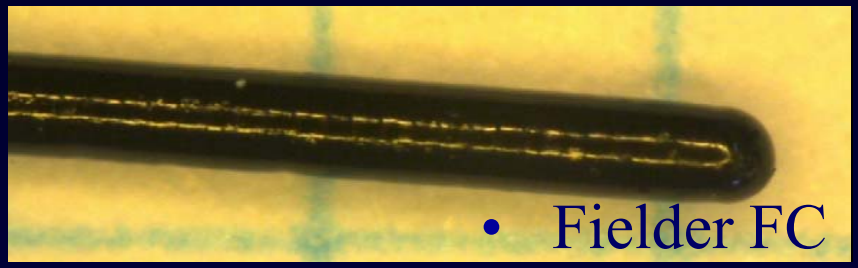
Fielder FC



Before Shaping



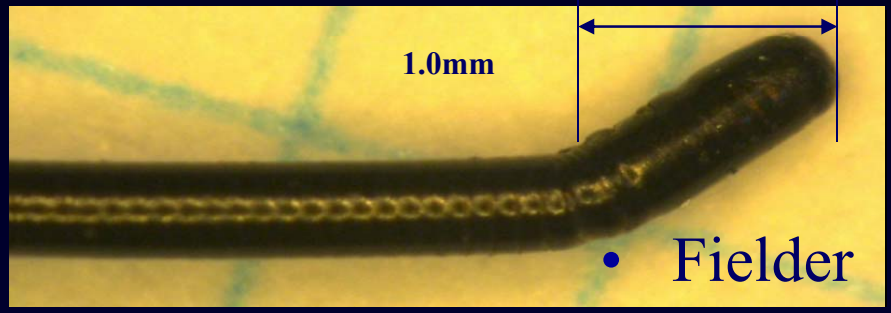
• Fielder



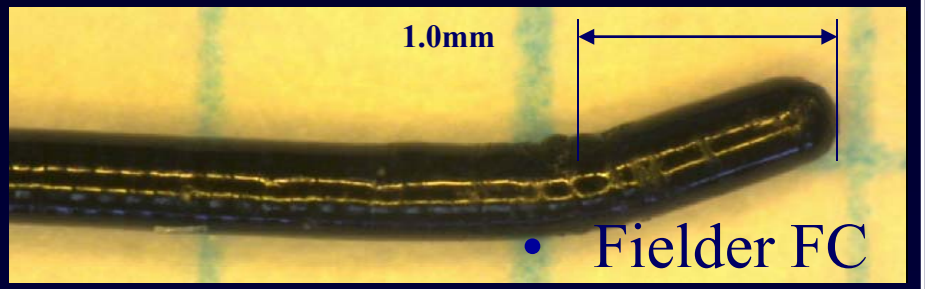
• Fielder FC

• Fielder XT

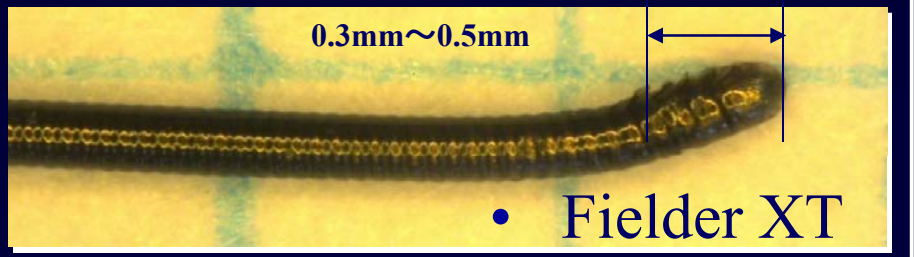
After Shaping



• Fielder



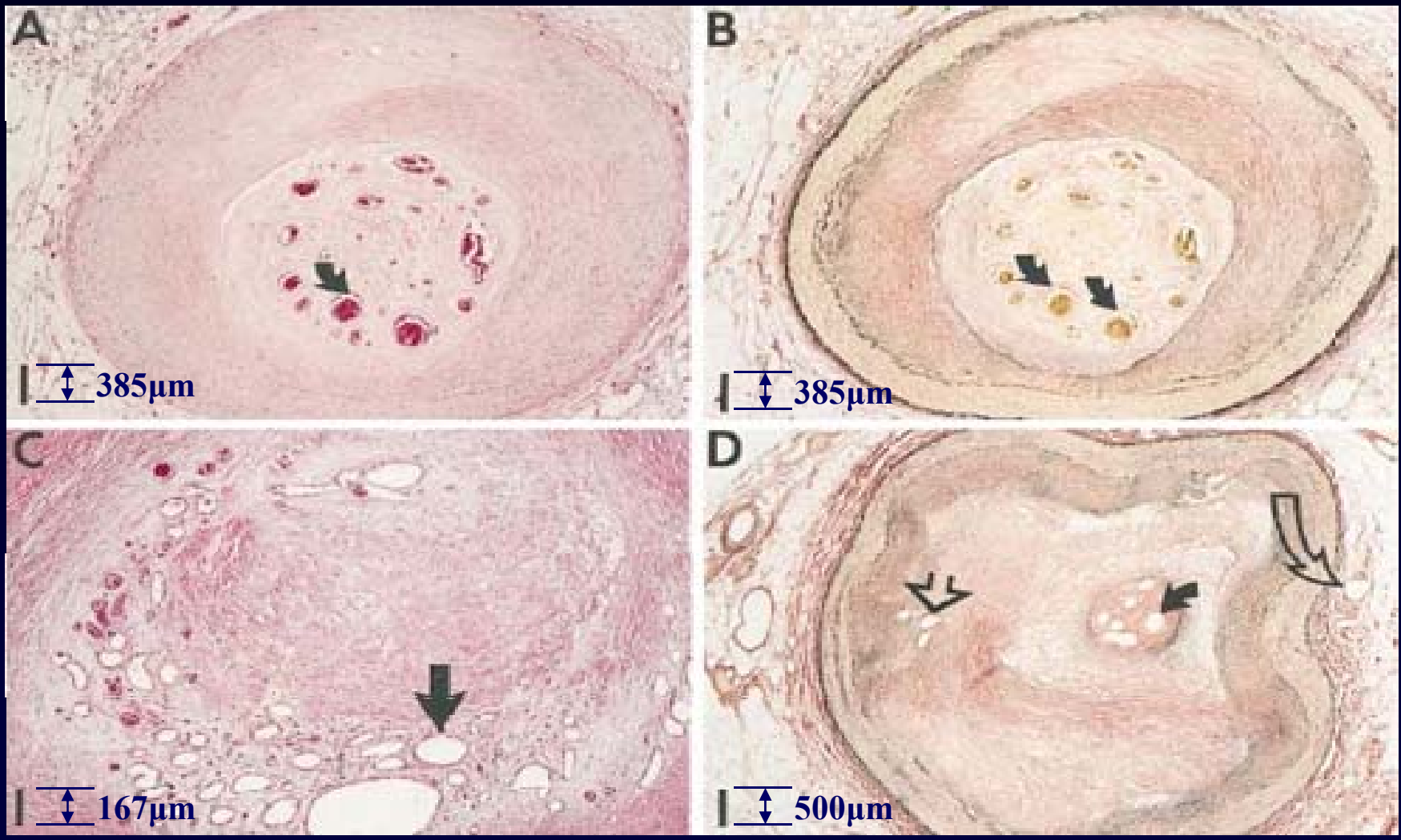
• Fielder FC



• Fielder XT

Fielder XT **enables precise tip shaping due to its short soldering tip.**

Micro Channels in CTOs



- Histological average size is 200μm (0.008 inch)

Single Wire Manipulation - 2

- Micro-channel in CTO

→ Hydrophilic soft wire (Fielder XT)

- Usual old CTO

→ Fielder XT

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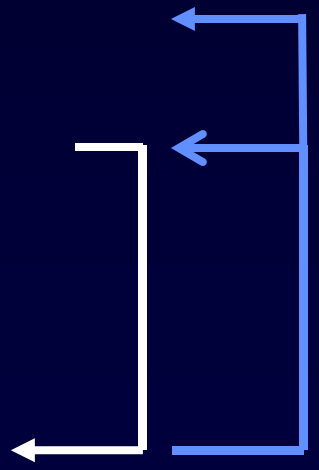
MIRACLE 3

↓

MIRACLE 6

↓

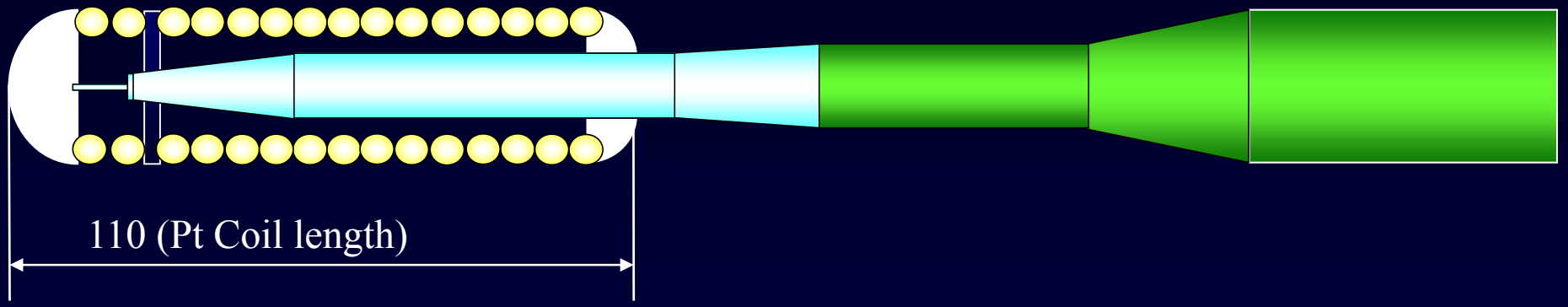
MIRACLE 12
or Conquest Family



After penetration of proximal fibrous cap

MIRACLE family

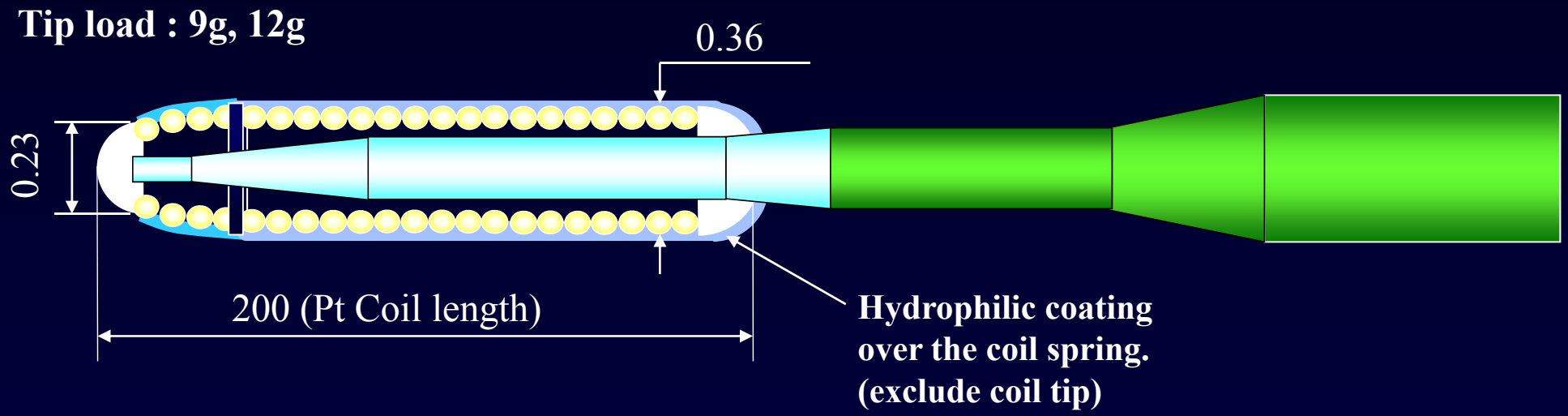
Tip load : 3g, 6g, 12g



▪ Applying the structure with further improves torque performance for CTO use.

▪ This tip part has the structure which is difficult to be trapped by the lesions.

Conquest family



- *Hydrophilic coating over the spring coil (exclude coil tip).*
- *Conquest Pro is hydrophilic coated version of Conquest. Higher slip ability is provided.*

Single Wire Manipulation - 3

- MIRACLE Family
  - Better torque performance
  - Less penetration force
  - Better crushing force
  - Better tactile feeling
- Conquest Family
  - Less torque performance
  - Better penetration force
  - Less crushing force
  - Less tactile feeling

Single Wire Manipulation - 4

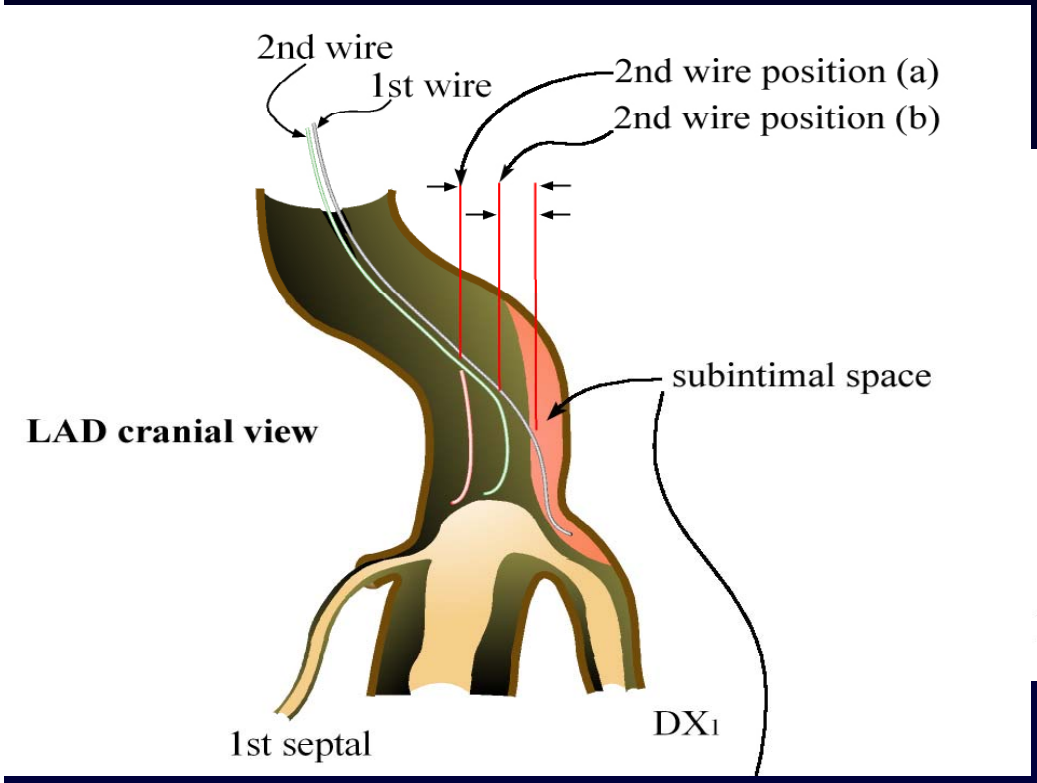
- **MIRACLE Family**

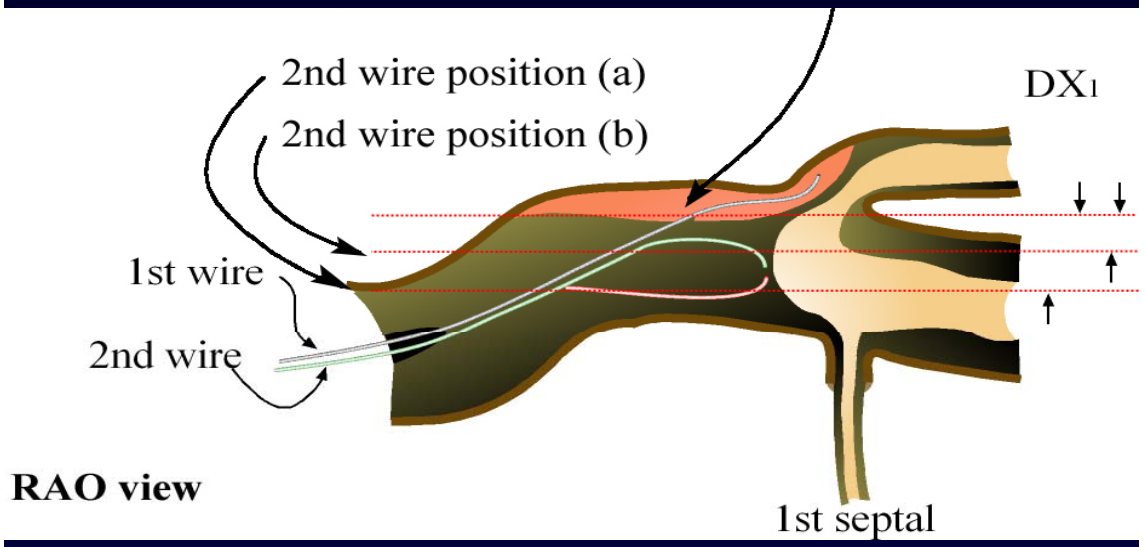
  is good for controlled drilling!

- **Conquest Family**

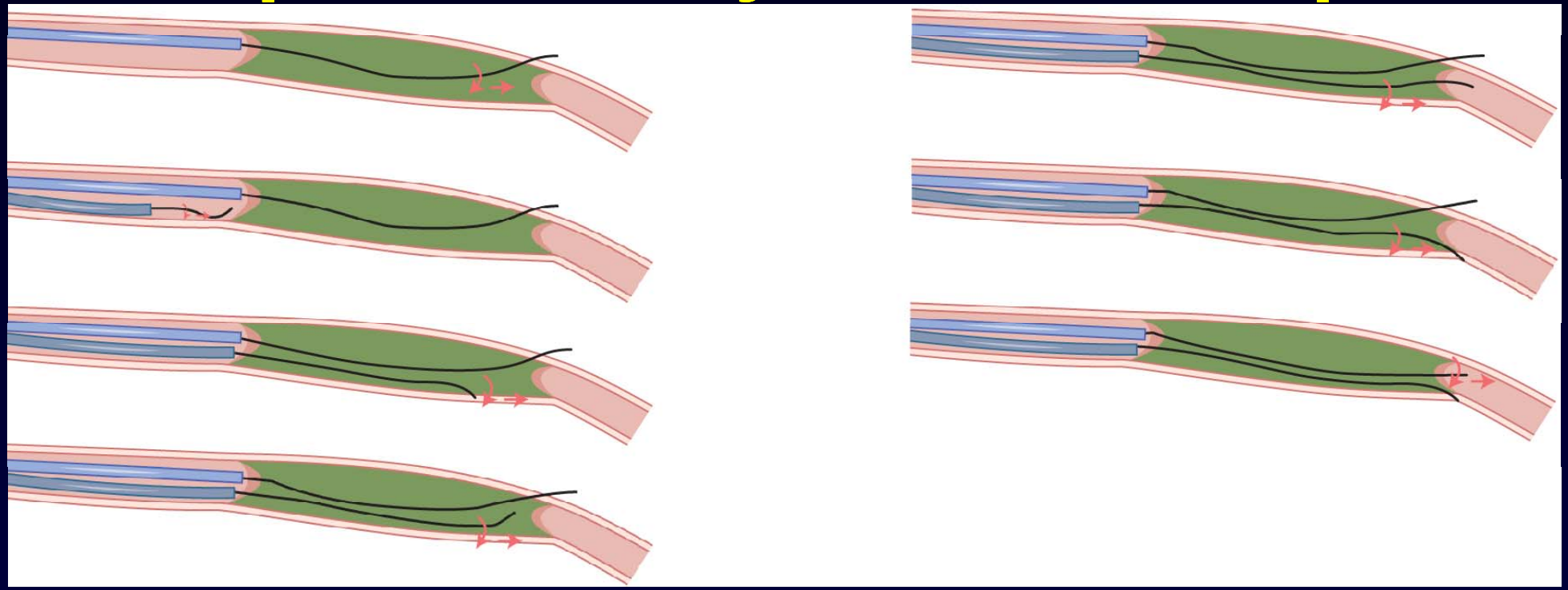
  is good for penetration technique!

Concept of Parallel Wire Technique



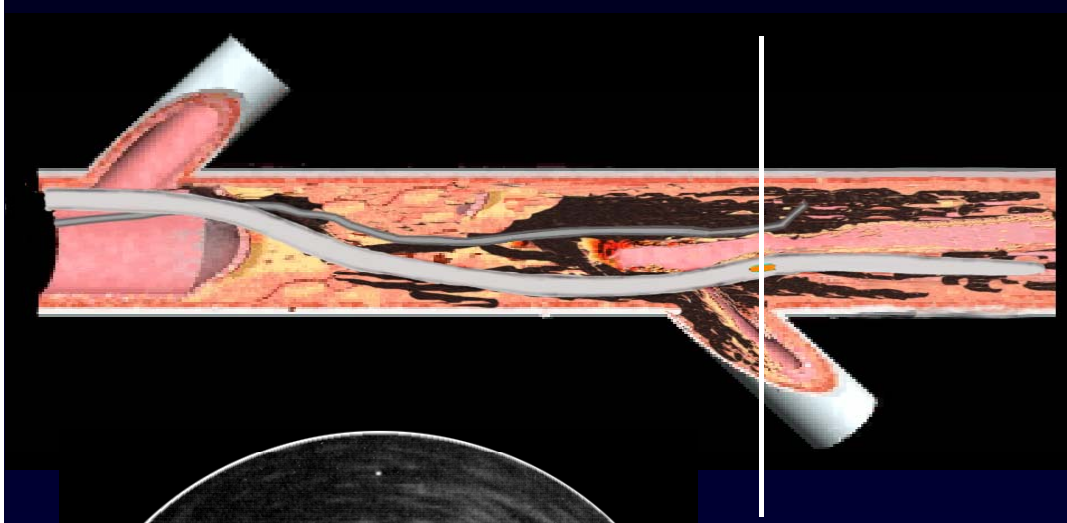


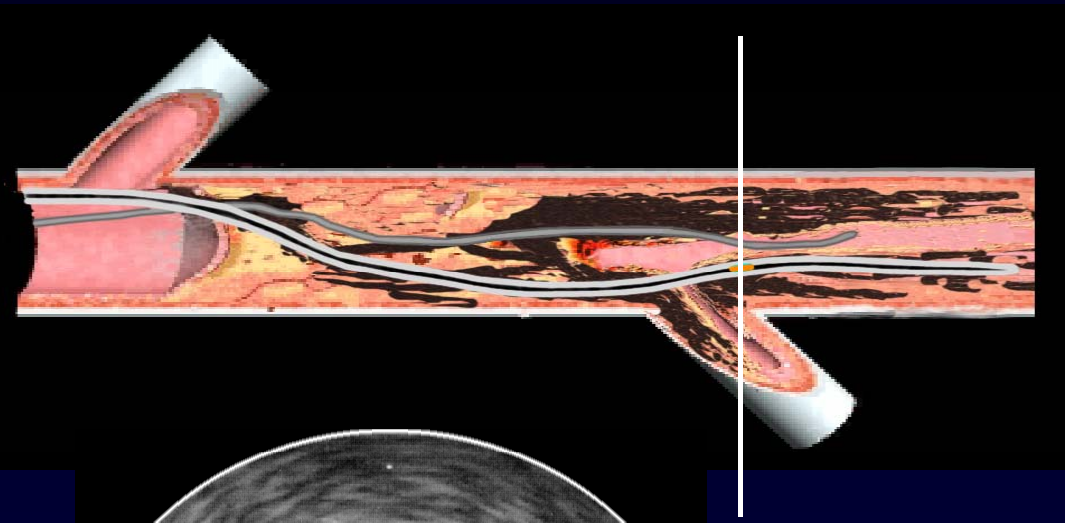
See-Saw Wiring or Stepwise Buddy Wire Technique

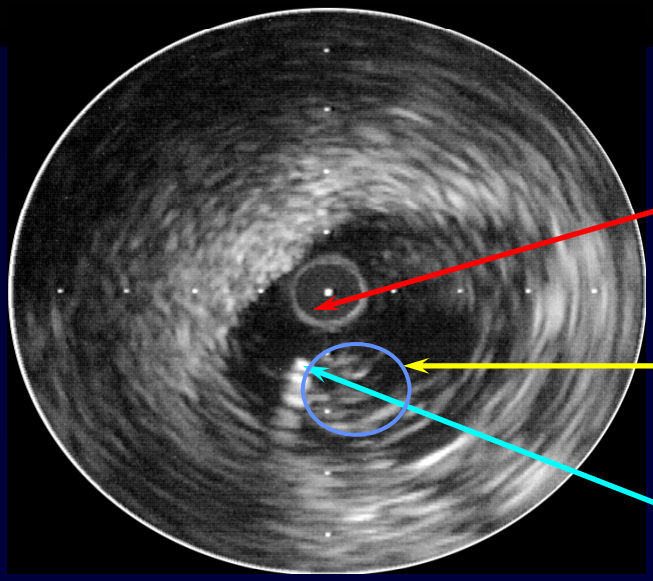


- Advanced form of parallel wire technique
- Using two microcatheters or OTW balloons
- Easy to change guidewires

IVUS guided wiring technique



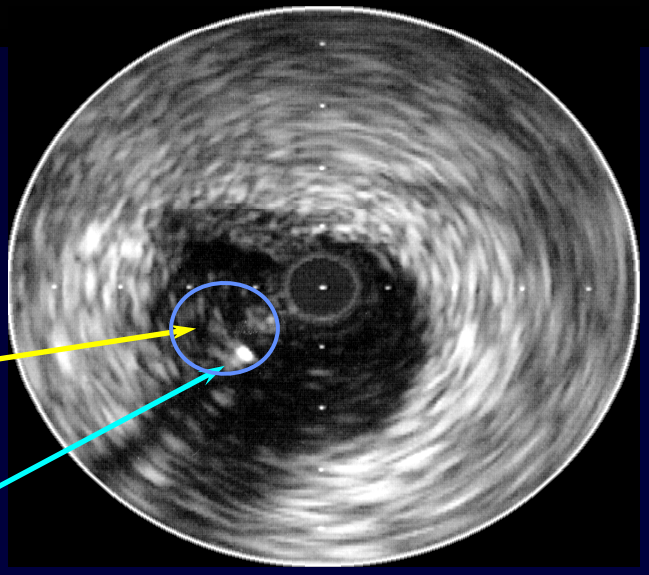




False lumen

True lumen

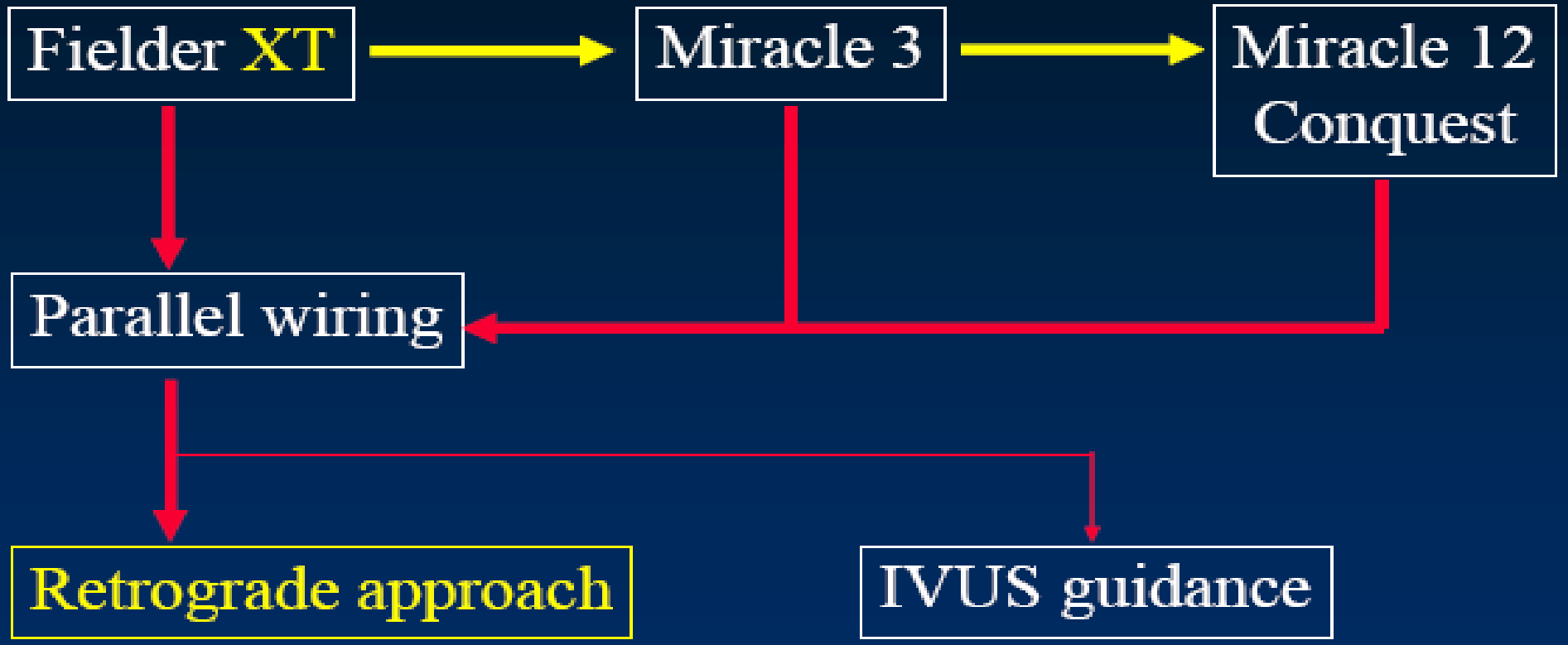
Guide wire



Technical pitfall and drawback of IVUS guided penetration

- Dilatation of subintimal space is required to deliver an IVUS catheter when necessary.
- This technique cannot be used if major perforation from subintimal space is already observed.
- 8Fr GC is required for simultaneous wiring with IVUS.
- Stiff wire such as Confianza are required.
- Multiple stenting is indispensable to fully cover the large subintimal space after successful wiring.

Current Antegrade Strategy for CTO



Wiring Strategy
Proposed by the Japanese Operators

Pre-procedural Examination of Angiogram w/wo MSCT

Antegrade approach

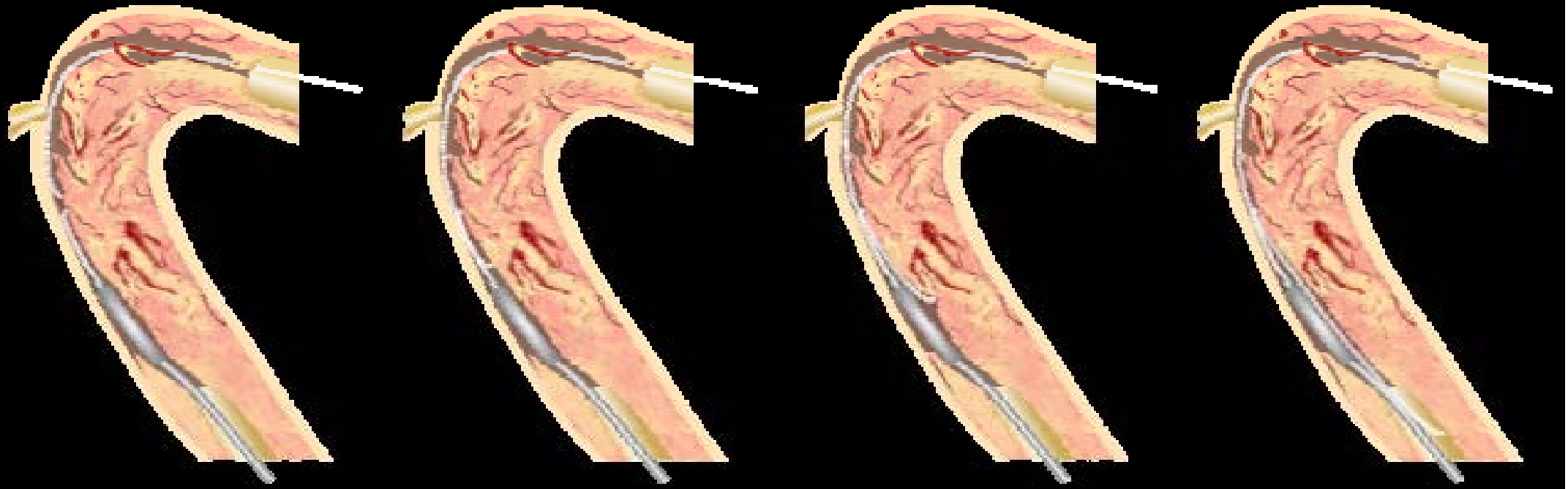
1. Single wire manipulation
2. Parallel wiring
3. IVUS guided wiring

Retrograde approach

1. Wiring through collateral
2. Retrograde wiring
   - Retrograde wire crossing
   - Kissing wire technique
   - Knuckle wire technique
   - CART
   - Reverse CART

Concept of CART™ technique

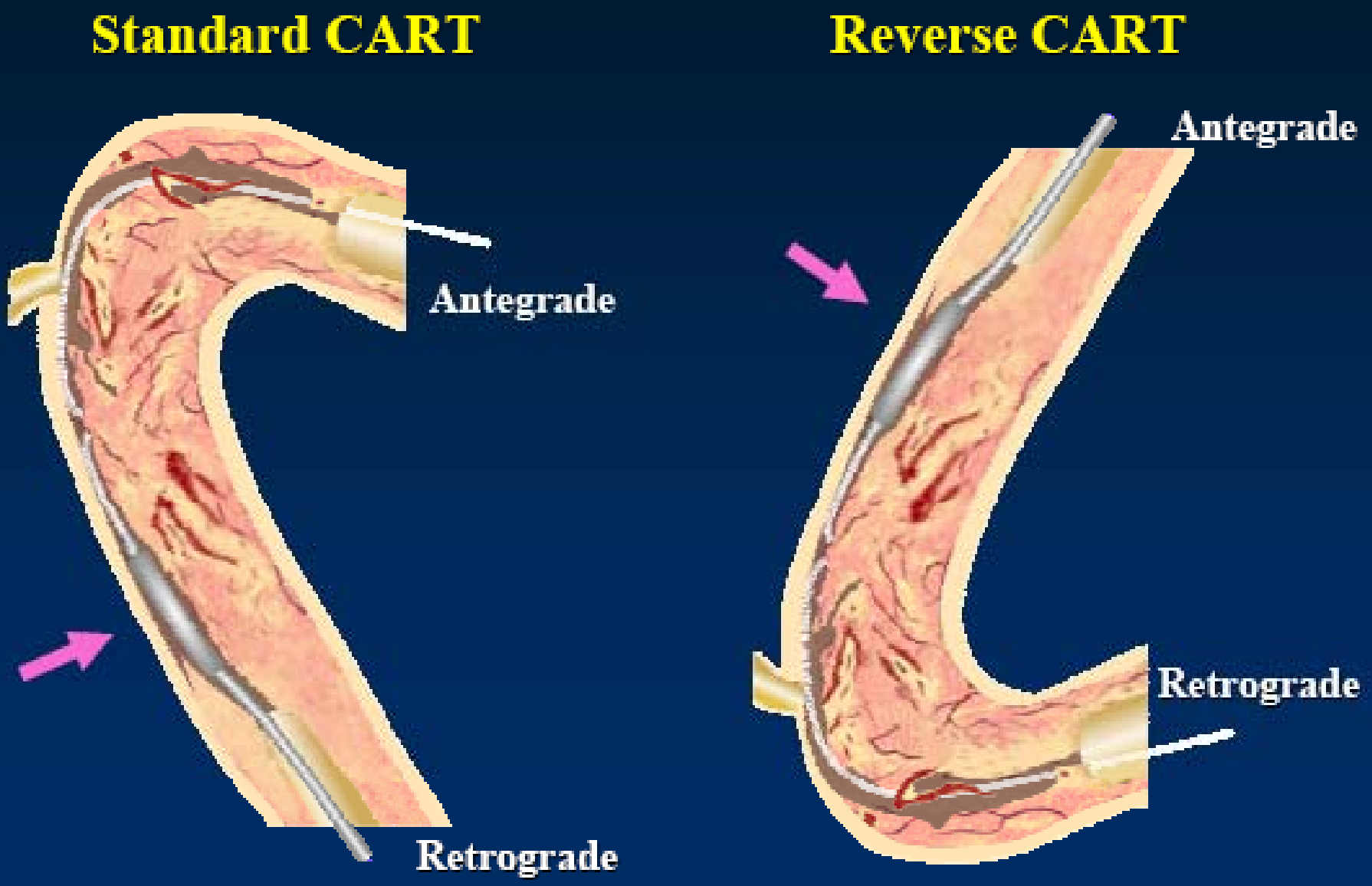
(Controlled Antegrade and Retrograde subintimal Tracking)



- **make connection between antegrade and retrograde subintimal space utilizing** behavior of subintimal dissection.
- **antegrade wire** automatically **gets into distal true lumen.**

Toyohashi Heart Center

CART vs. Reverse CART



Remaining Issues with Retrograde Approach

- Technical Complexity
  - Necessary to dilate channel, loss of wire manipulation, etc.
  - Learning curve
- Safety
  - Possibility of vessel perforation or rupture (especially with epicardial channels, leading to tamponade)

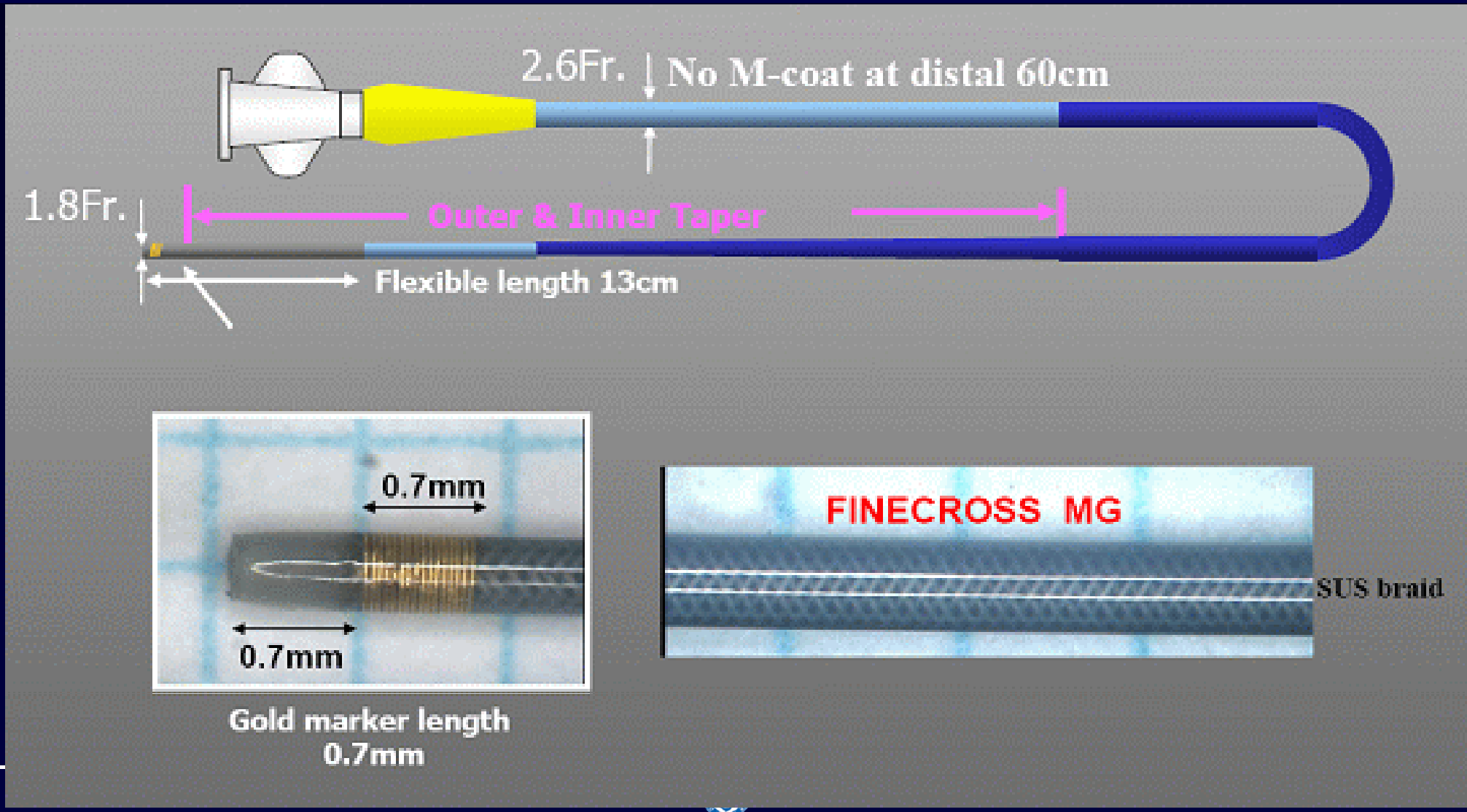
Guidewire-Support Devices

- Microcatheters
- Over-the-wire(OTW) balloon catheter
- Tornus
- Corsair (Channel-dilator)
- 5Fr Heartrail guiding catheter (using as Mother-child technique)

Comparison between OTW balloon and Microcathter

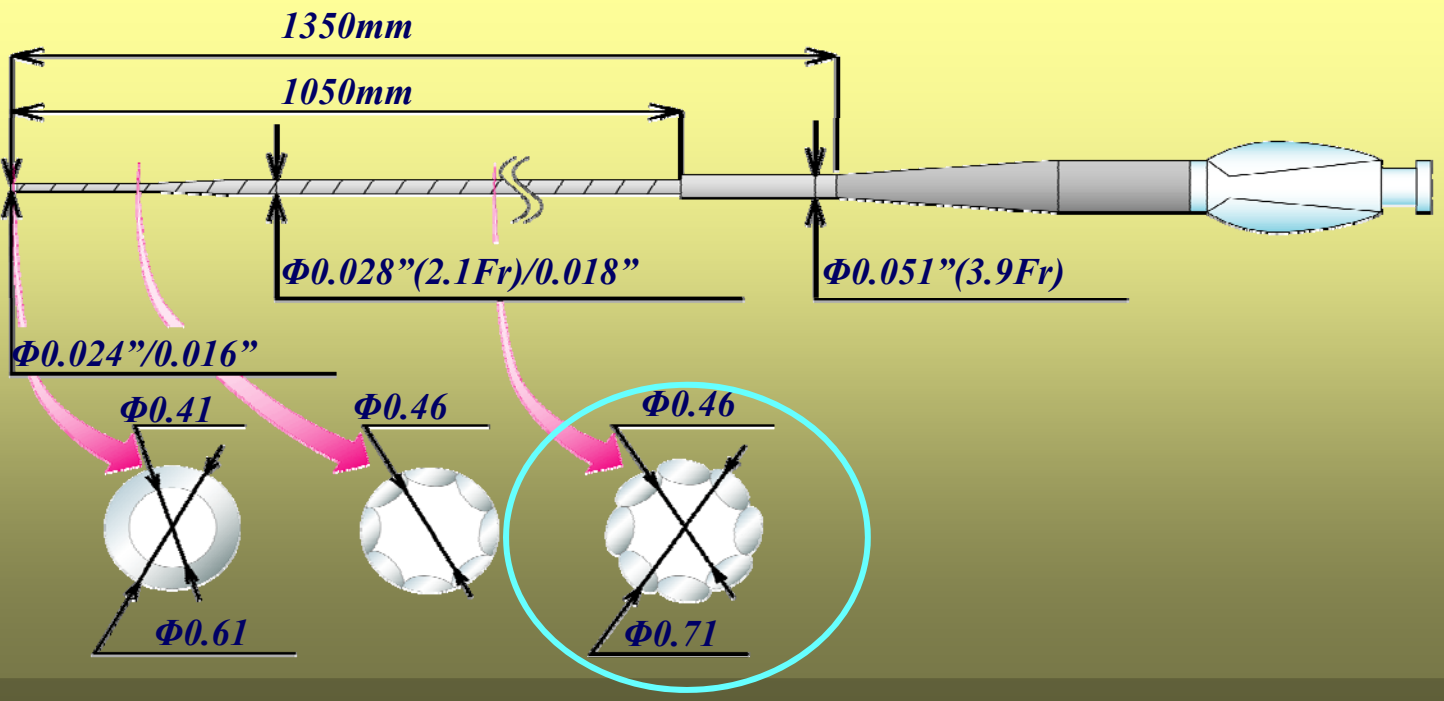
	OTW balloon	Microcatheter
Support power	excellent	weak
Penetration power	excellent	weak
Detection of tip location	difficult	easy
Contrast injection	difficult	easy
Flexibility	stiff	very flexible

Structure of Microcatheter (Finecross MG by Terumo, Japan)



Structure of Tornus 1

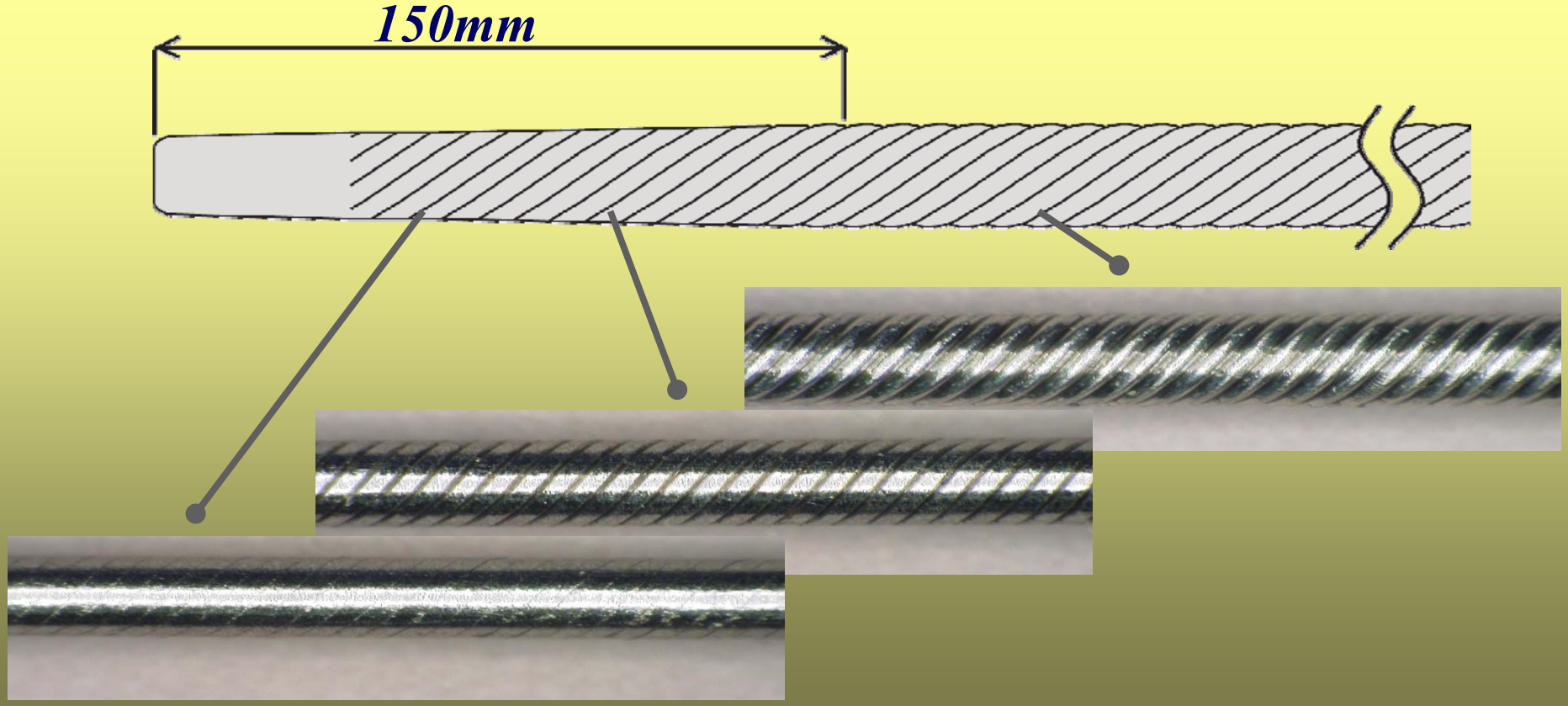
• **The metal catheter consists of 8 stainless steel ropes formed in a spiral structure.**



- Combined 8 wires enable high torque performance.
- Spiral structure gives high penetration power by counter-clockwise rotation.
- Helical cut surface provides stronger anchor effects.

Structure of Tornus 2

- **The tapered structure with 150mm from the distal tip.**



Structure of Tornus 3

- **Magnified Tornus Tips**

Tornus

Tornus 88Flex

Application of Tornus in CTO-PCI

1. Lesion penetration after wire crossing

- Enhanced power by Tornus 88flex, Tornus-Pro
- Wire exchange to RotaWire when necessary

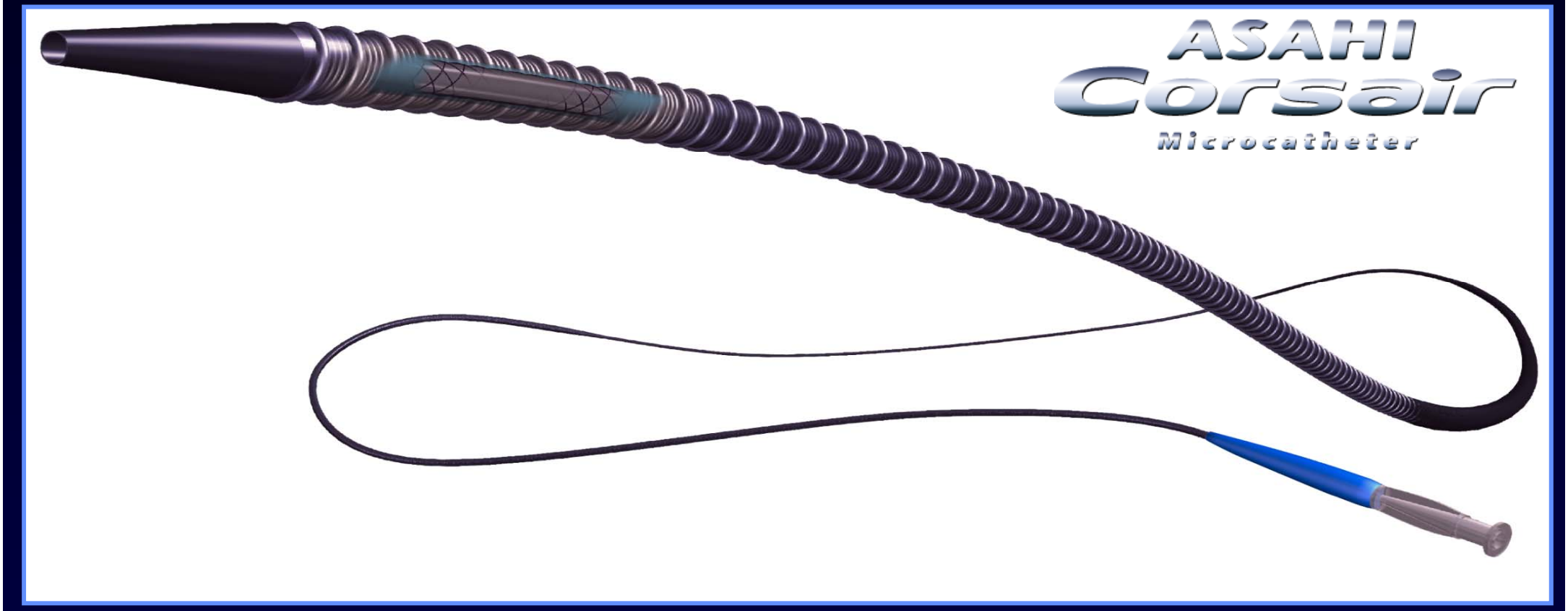
2. Support for wire handling

- For long tight CTO lesions
- To stretch the proximal wire kink
- Pay attention to the wire kink at the Tornus tip

3. Making channel

- Instead of balloon to avoid vessel dissection
- Before antegrade balloon in reverse CART

Channel Dilator *Corsair*



The Advantage of Corsair

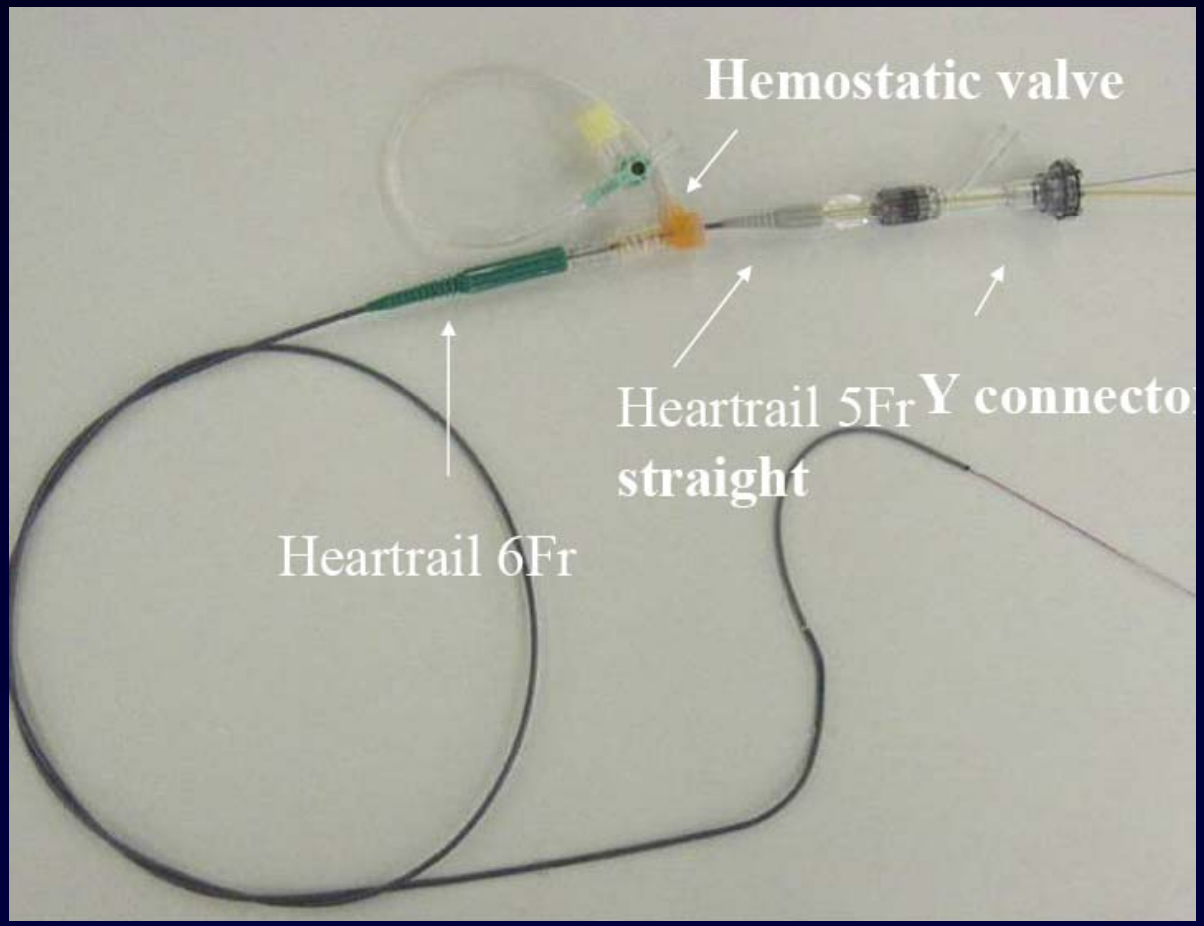
For Channel Tracking

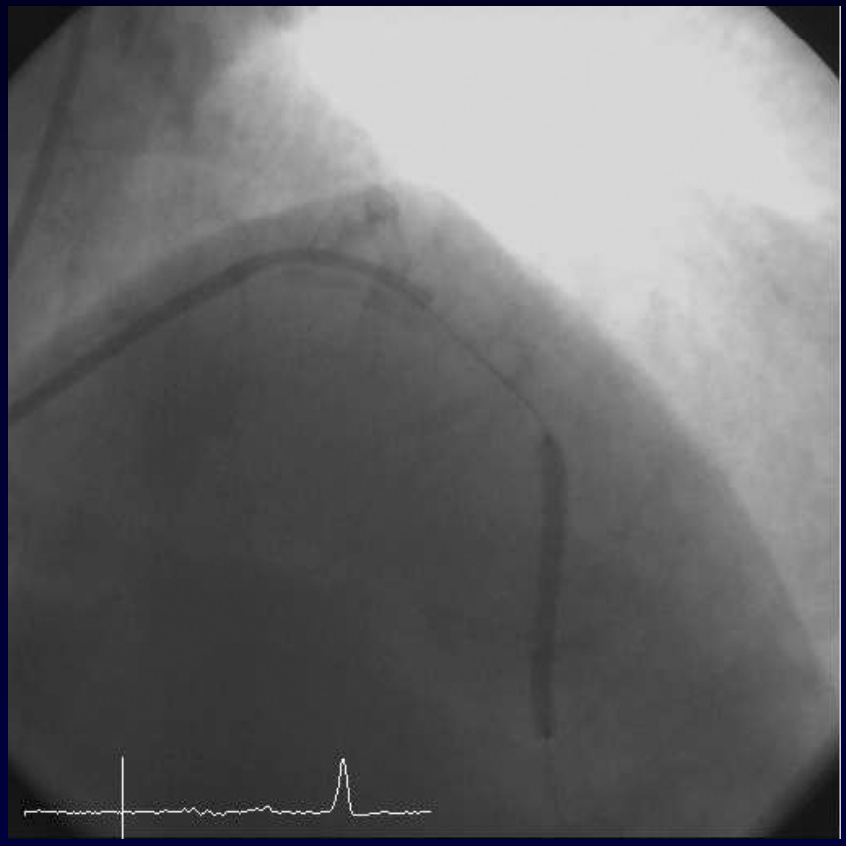
- Excellent cross-ability through collateral channel
- No need of channel dilatation
- Less channel injury
- Expanded indication for epicardial channel

For Retrograde Wiring of CTO

- Excellent support for wire manipulation
- Good cross-ability into/through the occlusion
- Enabled usage of 300cm wire or snare wire

Mother-Child Catheter Method – 5 Fr Heartrail (Terumo, Japan)





5Fr Heartrail in
6Fr guiding cathter

Clinical Impact of MDCT on PCI of CTO

- Regional distal calcium scoring can be useful to predict procedural outcome with antegrade approach in PCI of CTO.

- By quantitatively evaluating amount of calcium, identifying the route and the length of the CTO segment, MDCT may be useful for Pre-Procedural Strategy judgments for PCI method of CTO in the future.

Standardization of Pre-Procedural Strategy For CTO-PCI

Patient with CTO

↓

64 MD CT angiogram

↓

Use Beta-blocker to slow down HR

↓

Simultaneous both coronary angiogram

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Critical evaluation of coronary angiogram

Standardization of Pre-Procedural Strategy For CTO-PCI

- Easily seen distal stump, or microchanell by angio
- Occluded segment <30 mm by MDCT
- Low distal stump calcium by MDCT (Calcium Area<4mm^2)

- Poorly seen distal stump, without microchanell by angio
- Occluded segment >30 mm by MDCT
- High distal stump calcium by MDCT (Calcium Area>4mm^2)

No Good Channel

Antegrade Approach ⟷ **Retrograde Approach**

Failed Ante

Severe calcium and/or angulation in mid lesion or fail to antegrade and retrograde approach

CART or Retrograde CART technique

73 Year-old woman

C.C Chest pain for 1 month

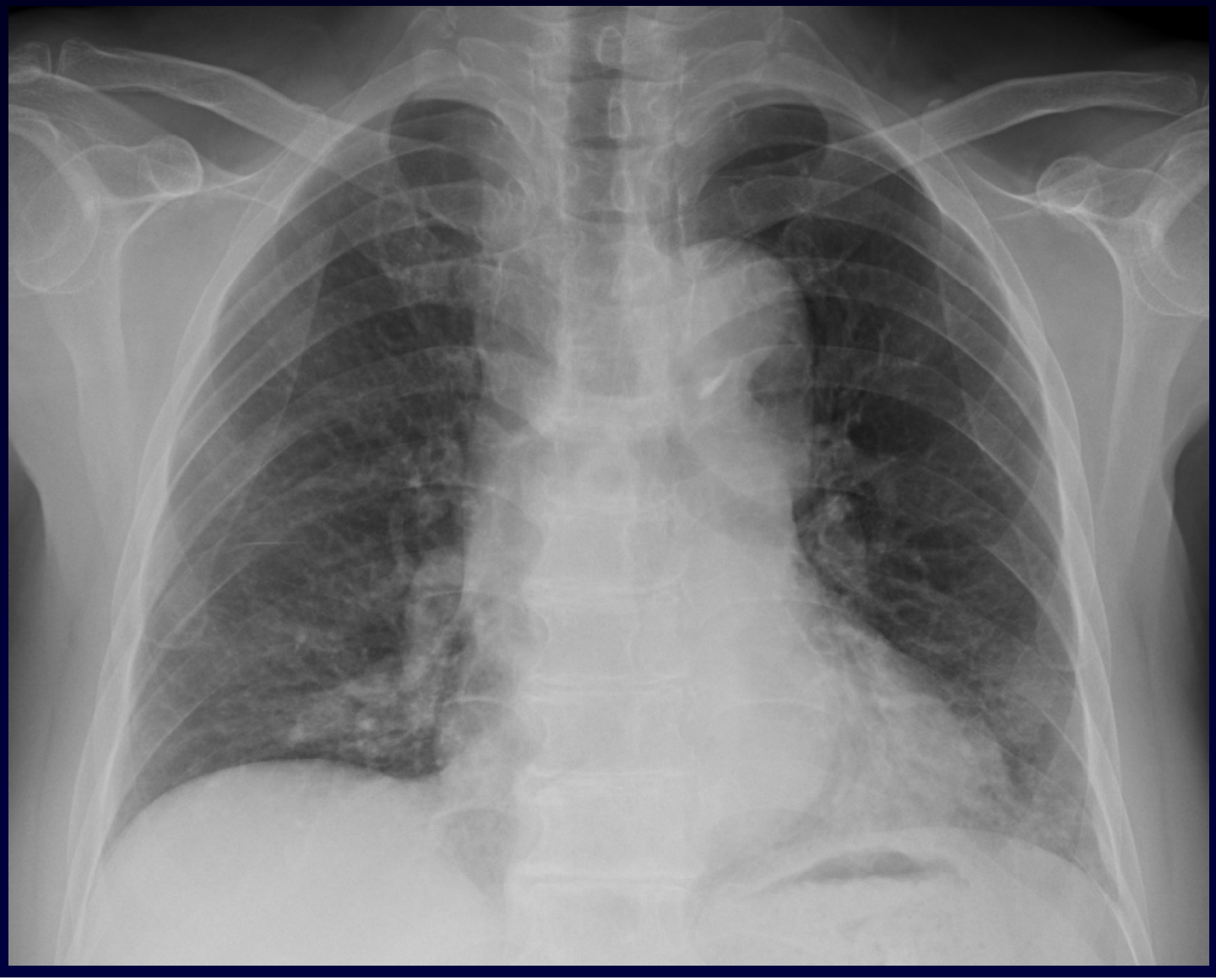
P.Hx HTN (+) on medication for 10yrs

R.O.S Dyspnea (-)
Chest pain (+)

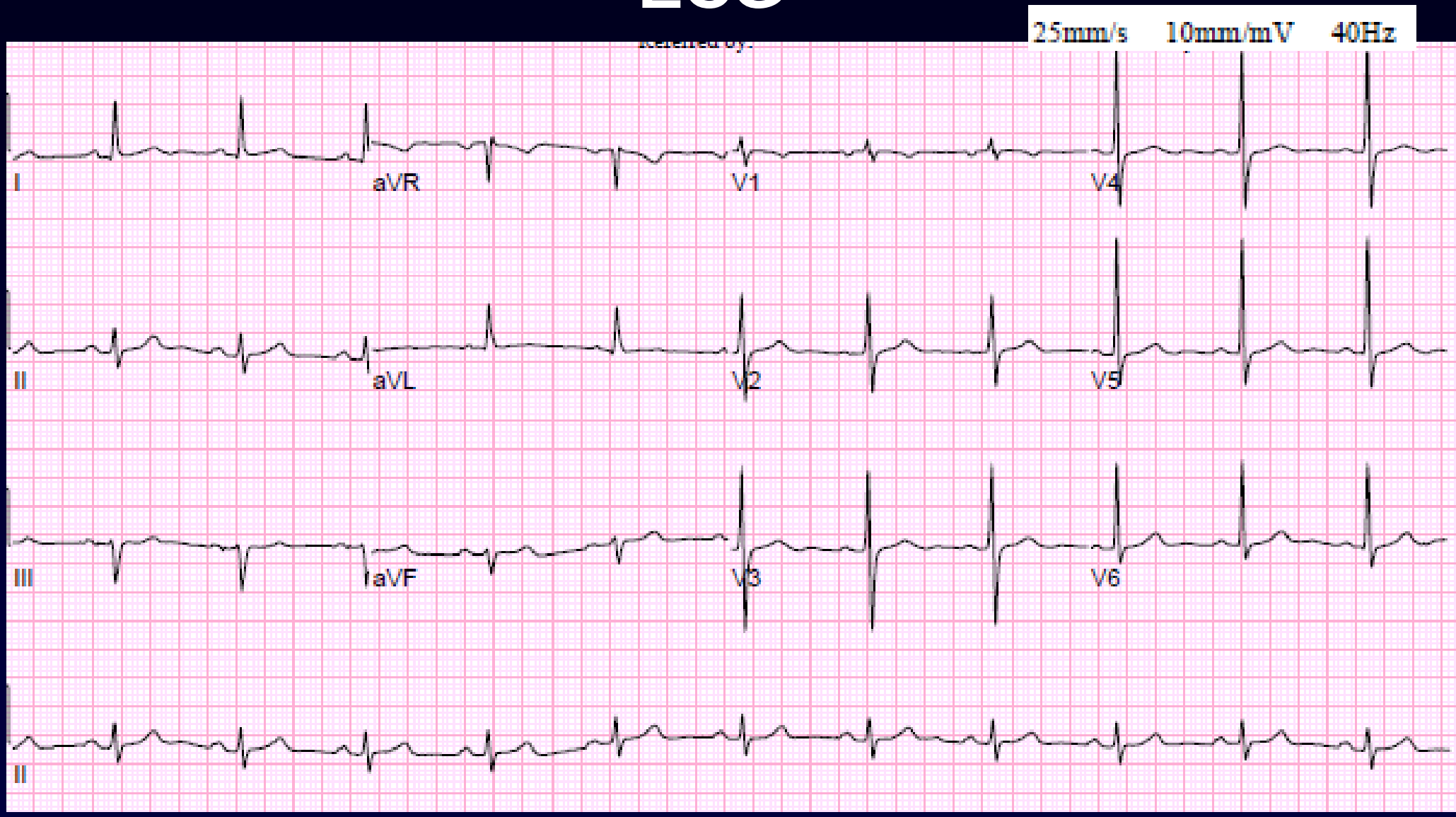
P.Ex V/S 120 / 80-72 - 20 - 36.6
RHB without murmur
CBS without rale, wheezing

 # 5460316

Chest PA

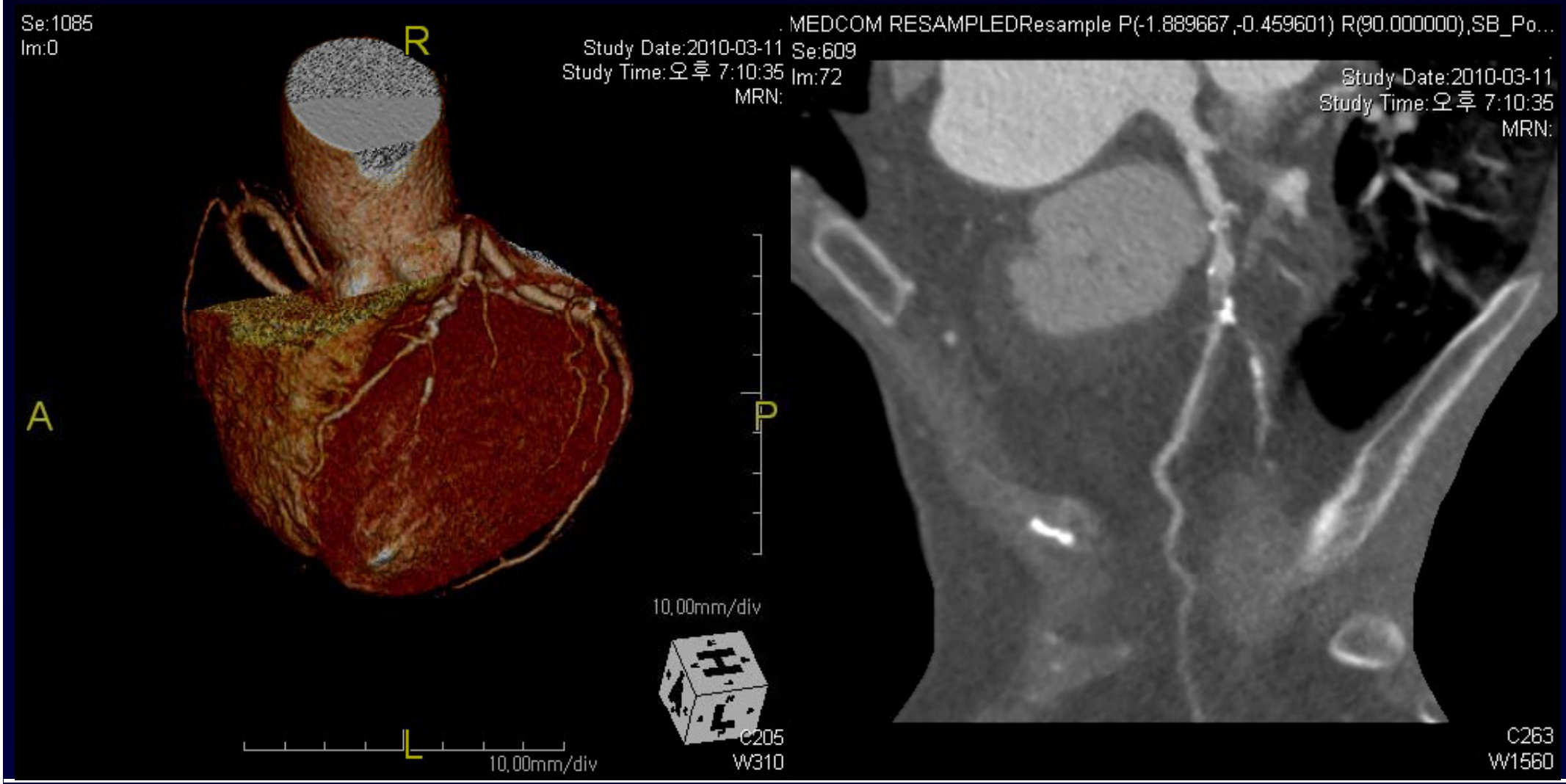


ECG



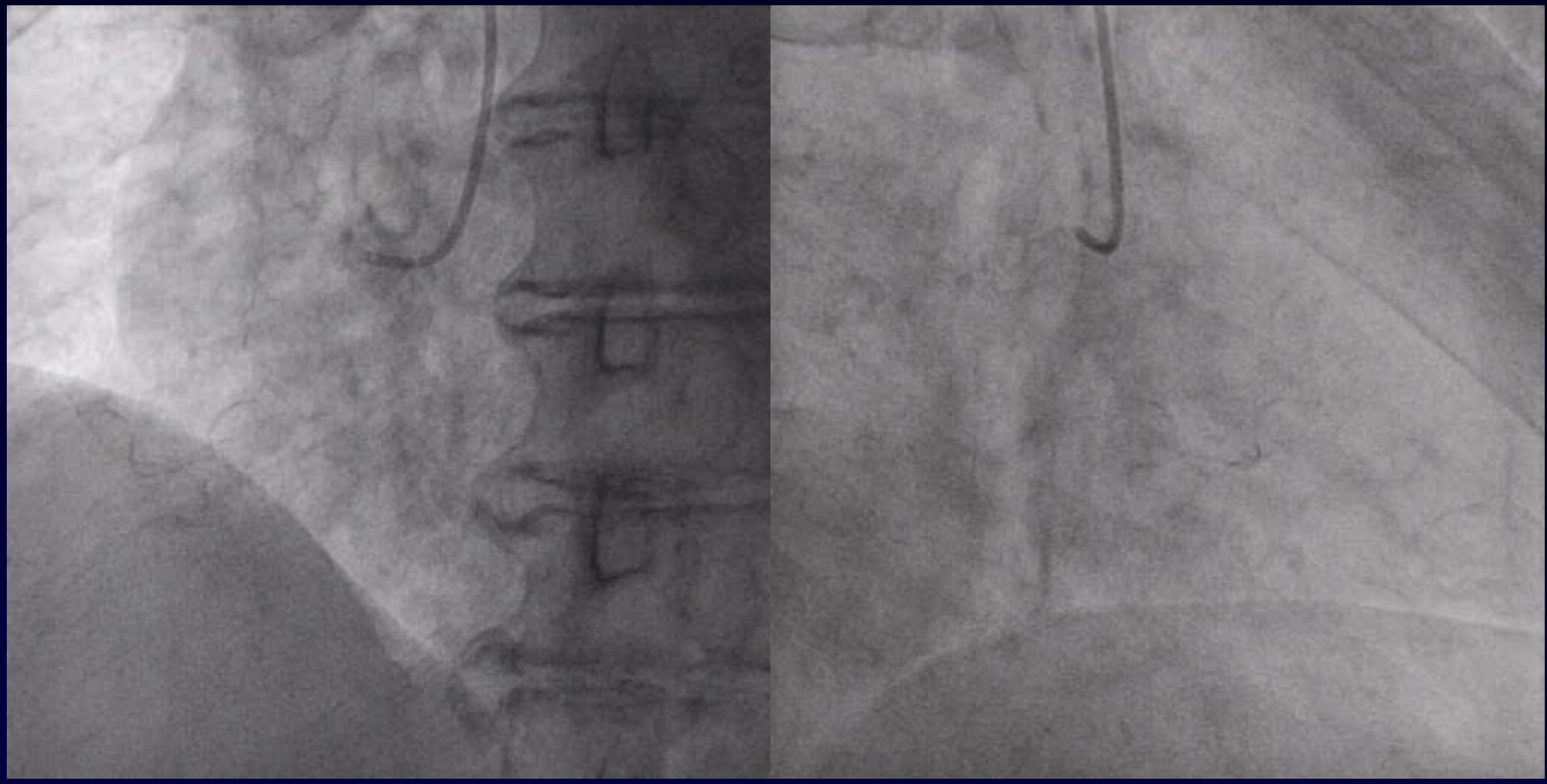
Initial diagnostic approach

Cardiac CT



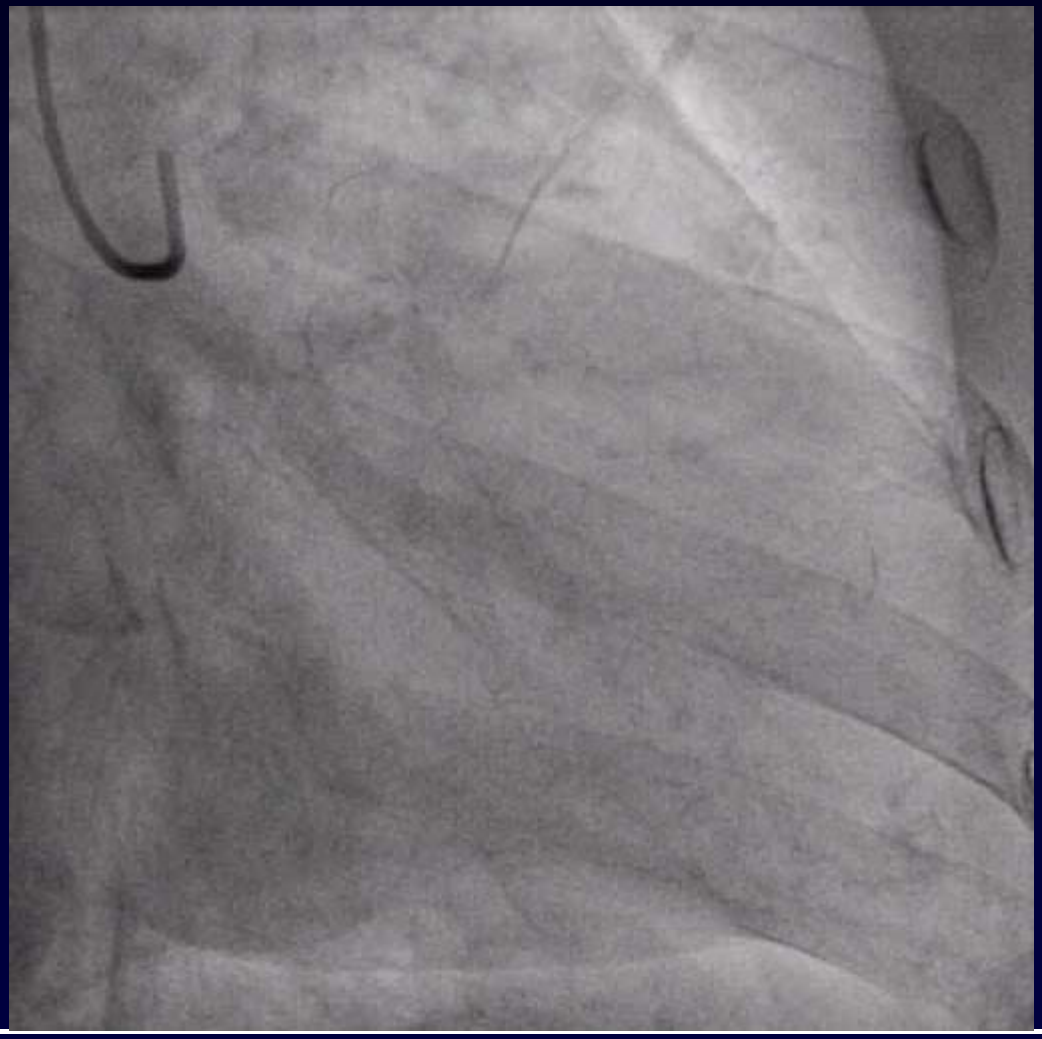
Initial angiography (RCA)

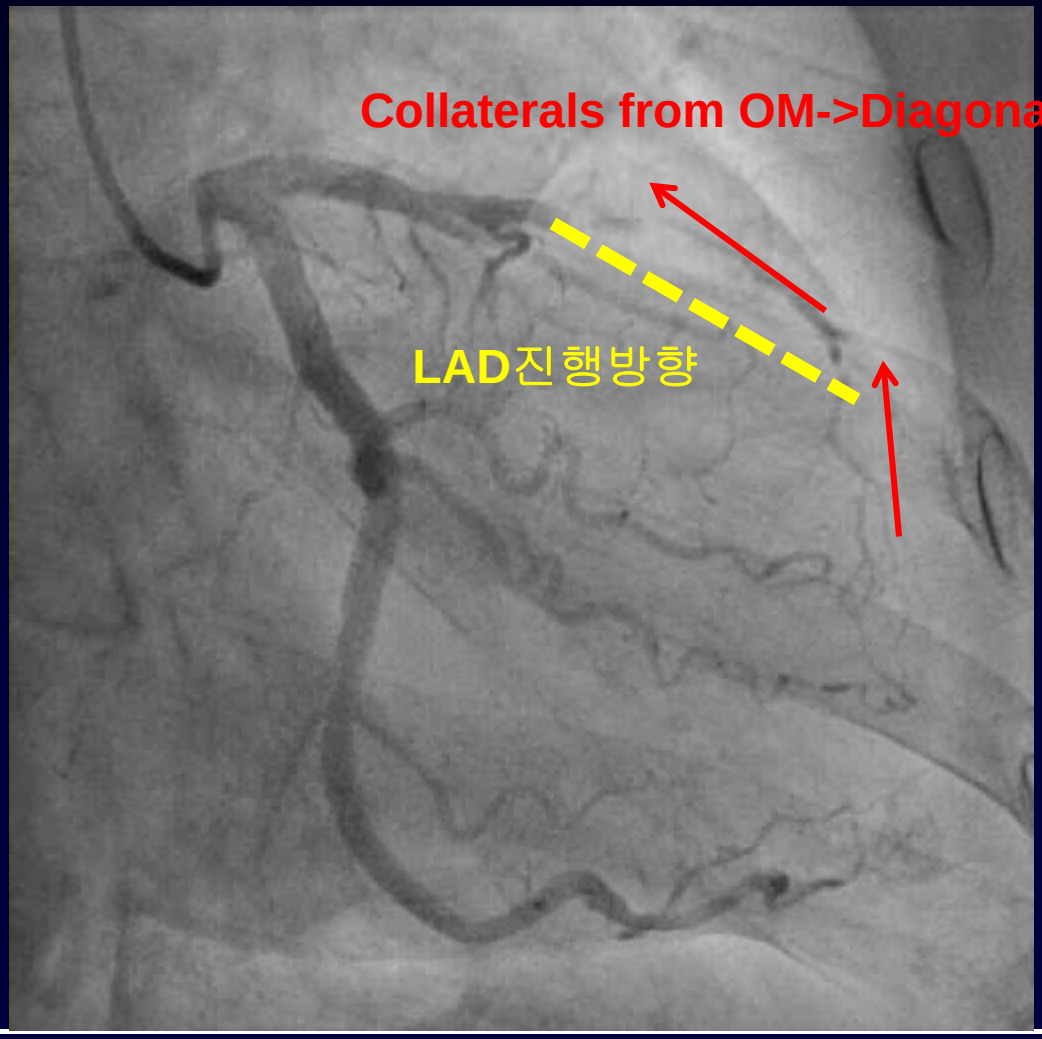
2010-03-21



Initial angiography (LCA)

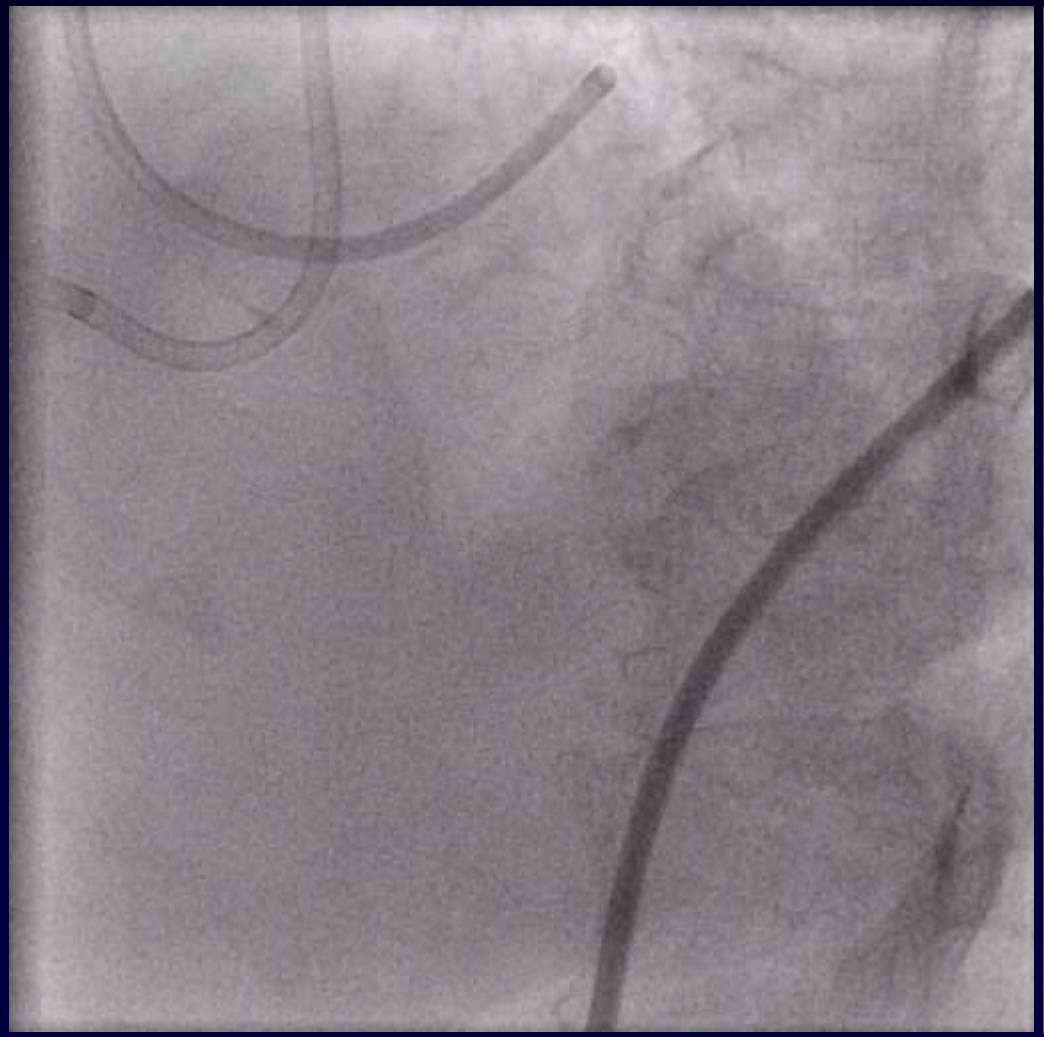
RAO caudal view

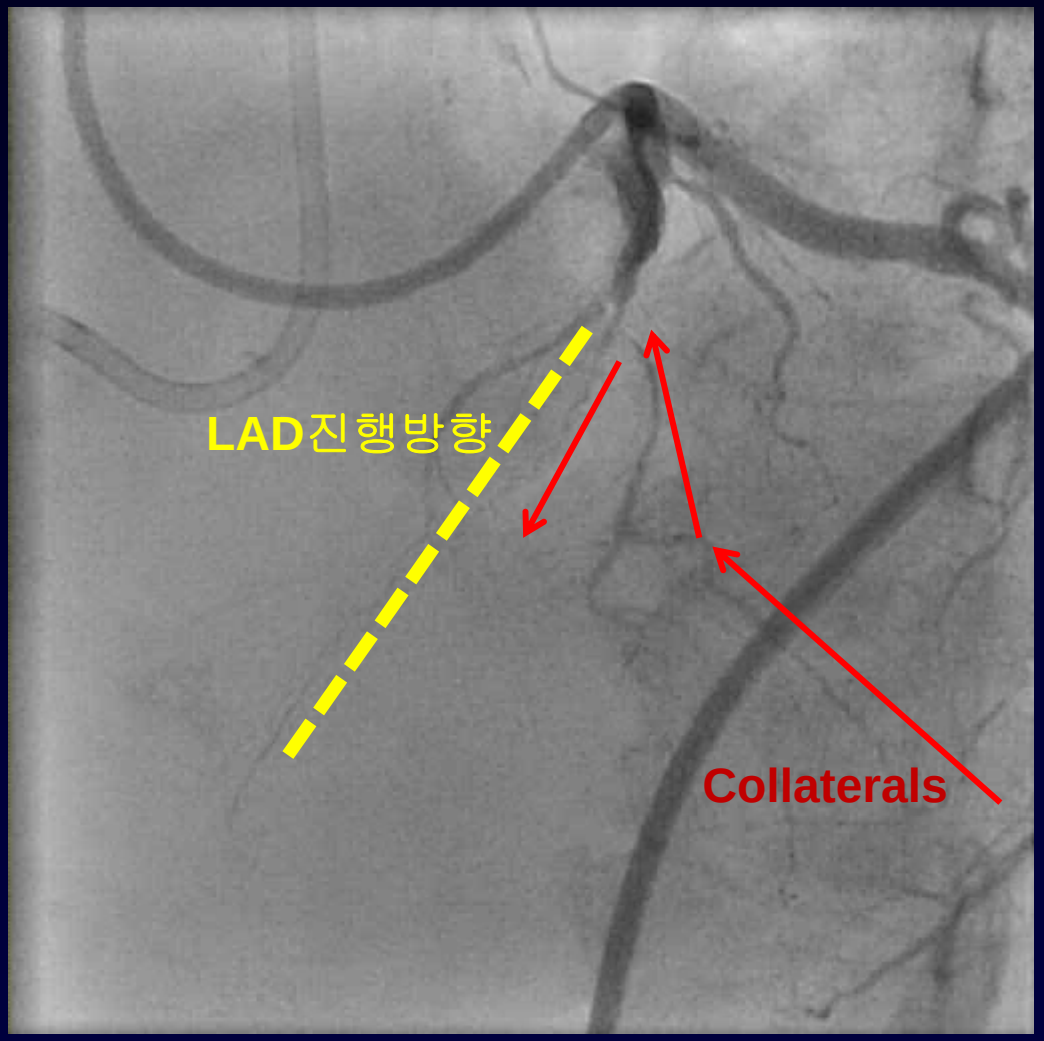




LCA angiography

LAO cranial view

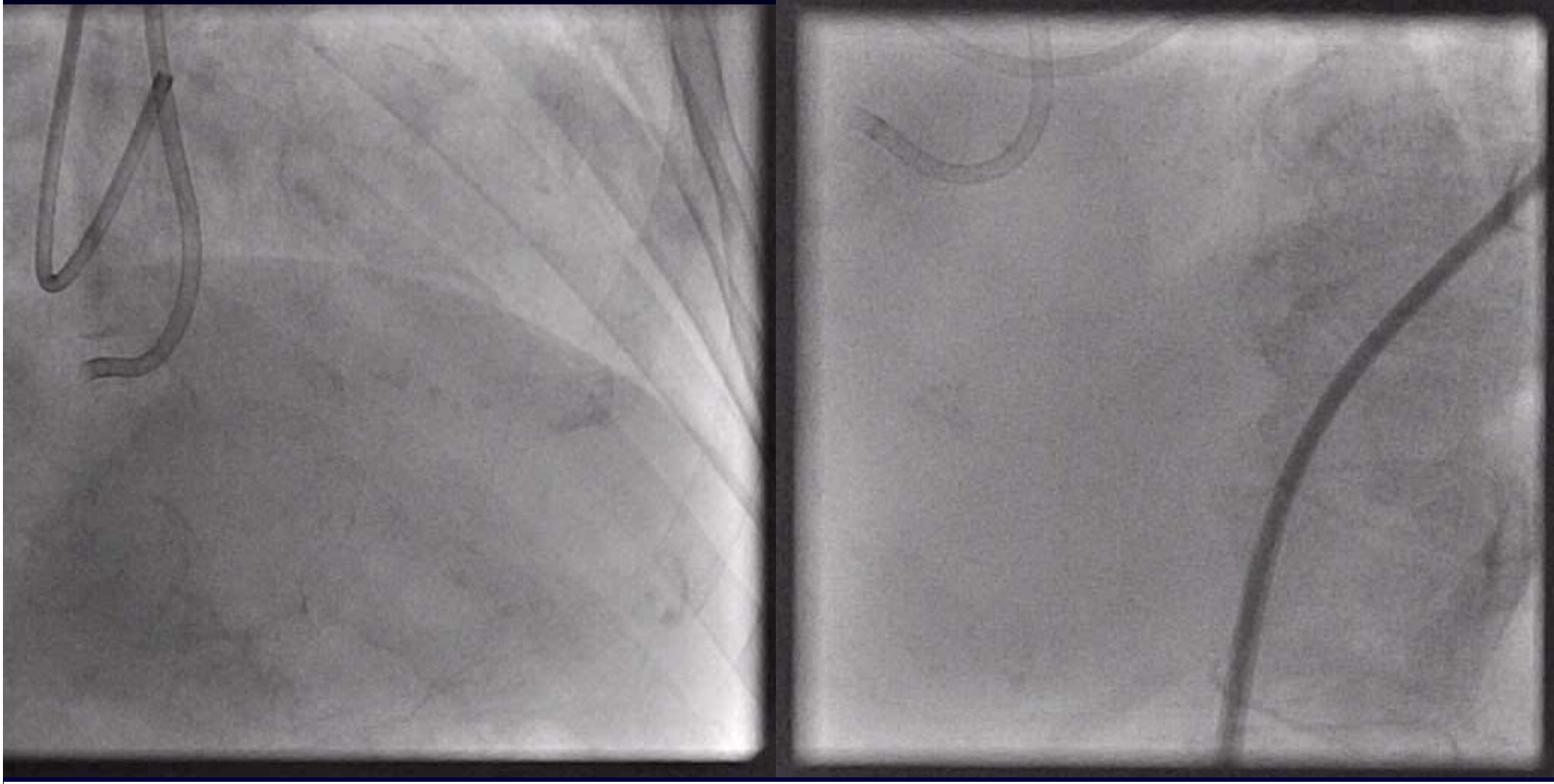




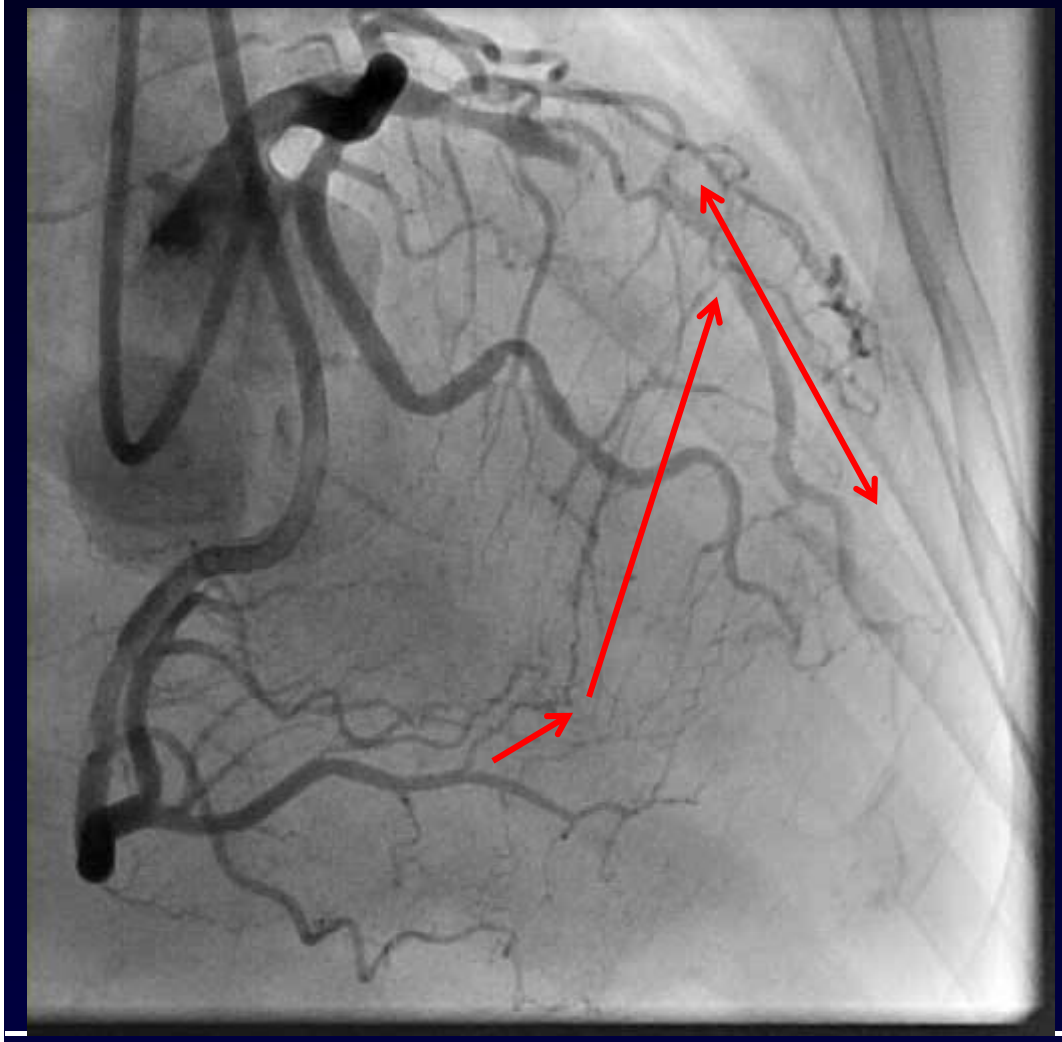
Dual (bilateral) angiography

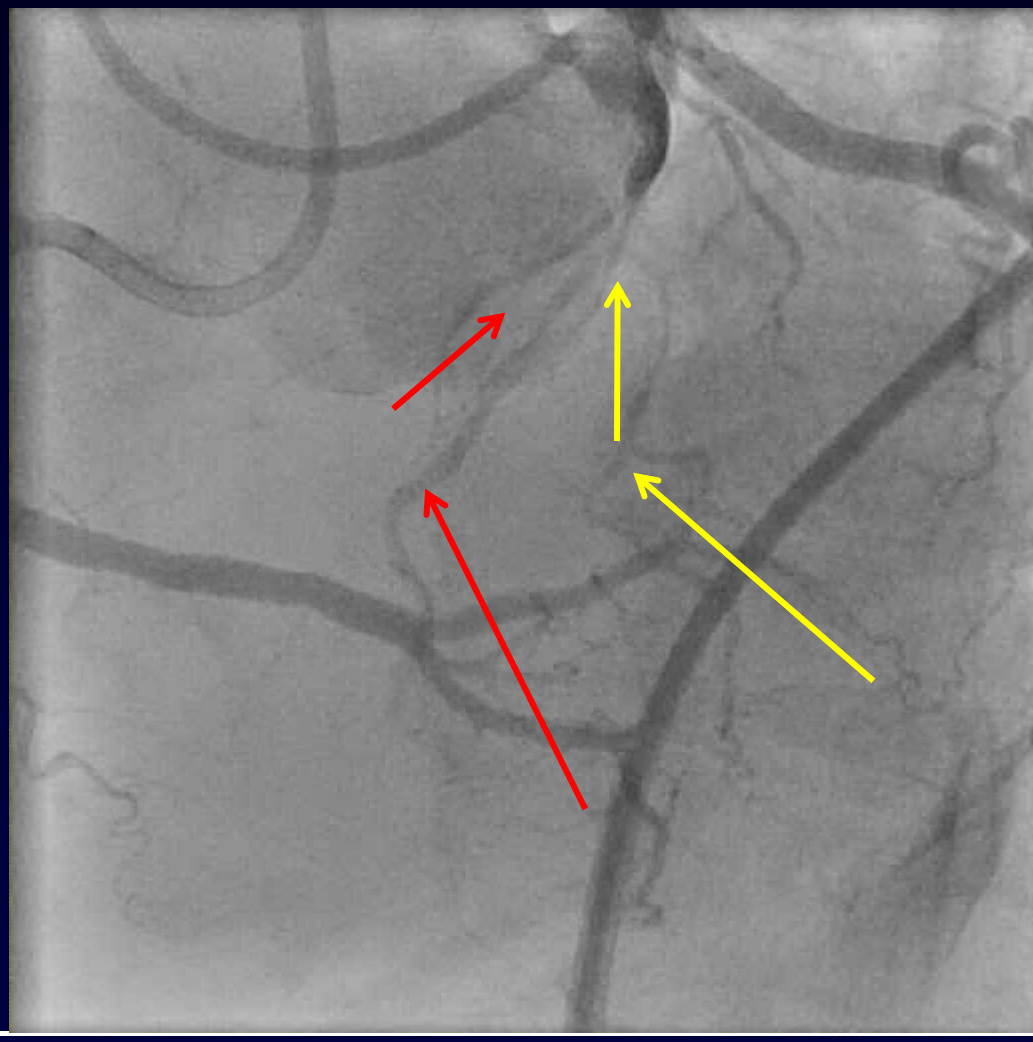
RAO cranial view

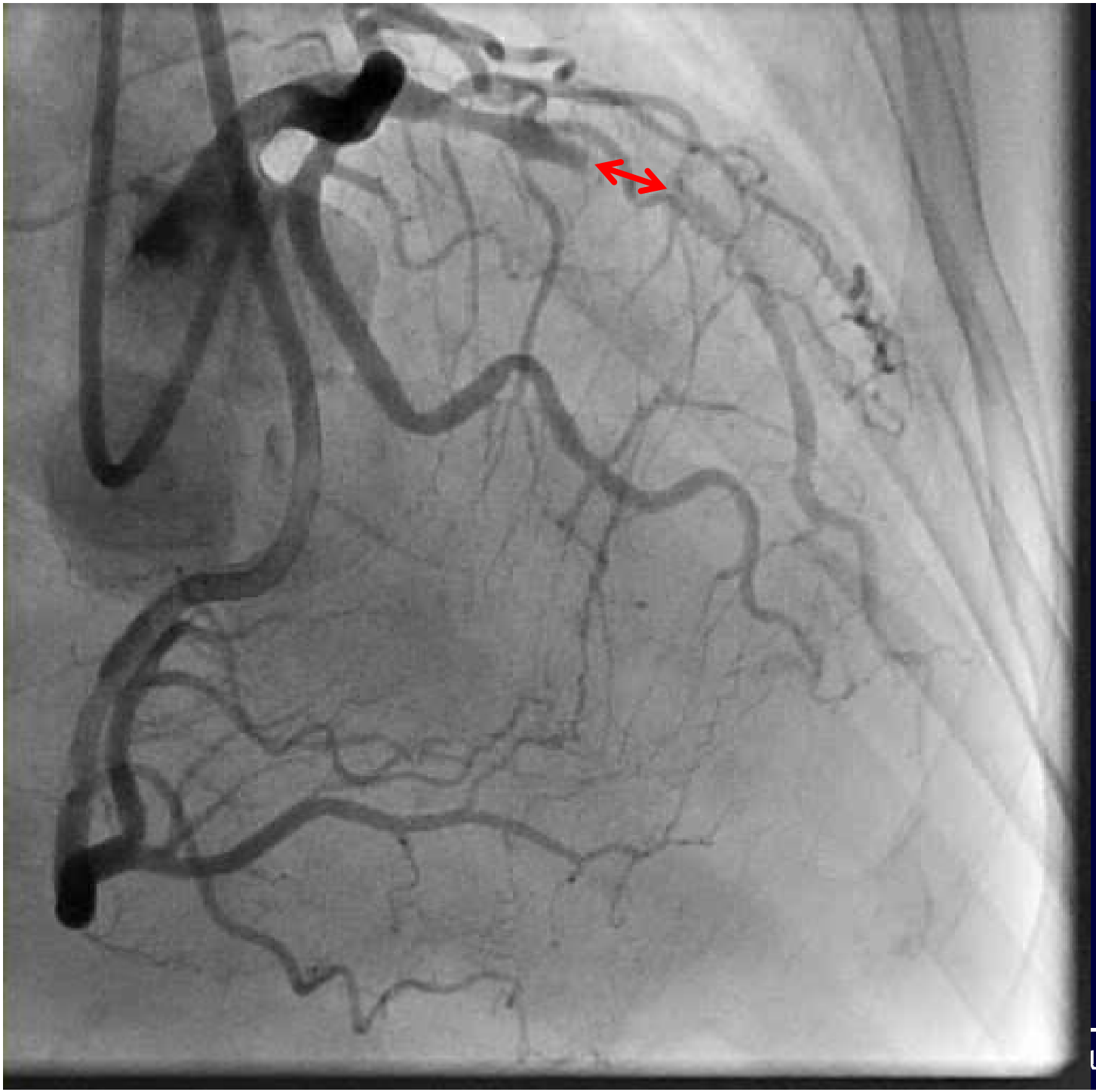
LAO cranial view



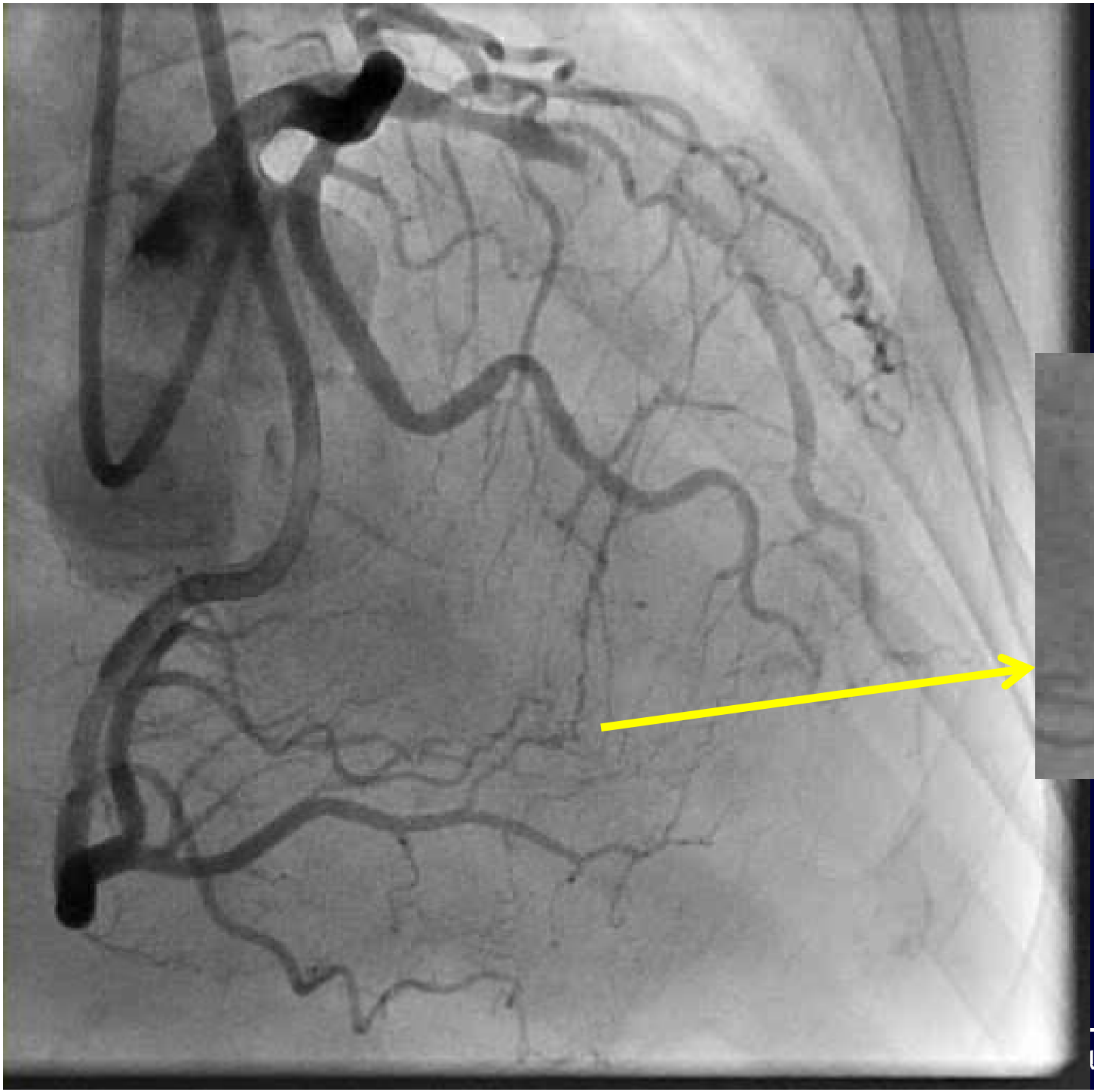
Collaterals from PD->septal, OM->diagonal







Could estimate obstructed lesion length

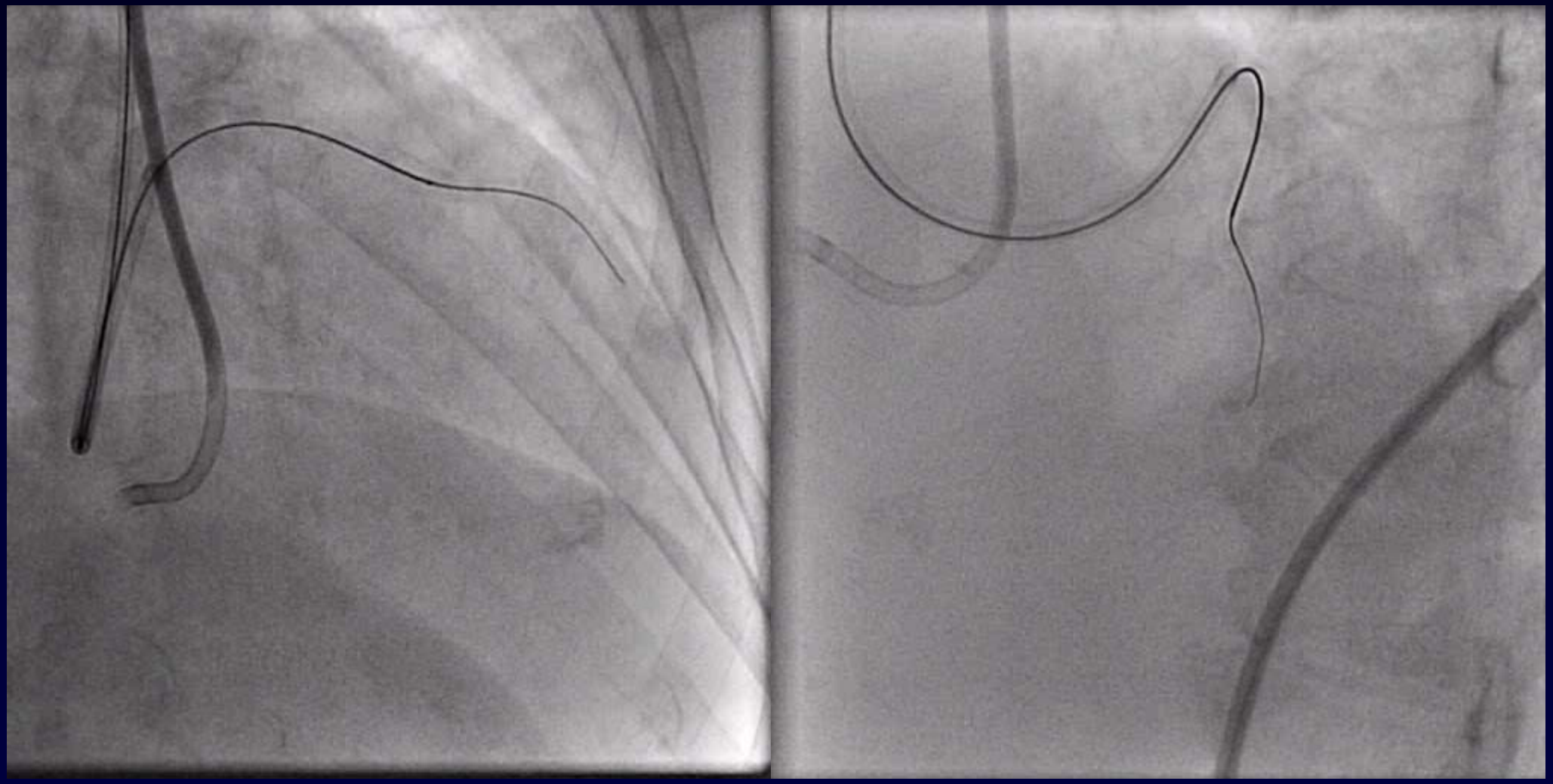


Could determine revascularization strategy

Retrograde approach: Too complicate

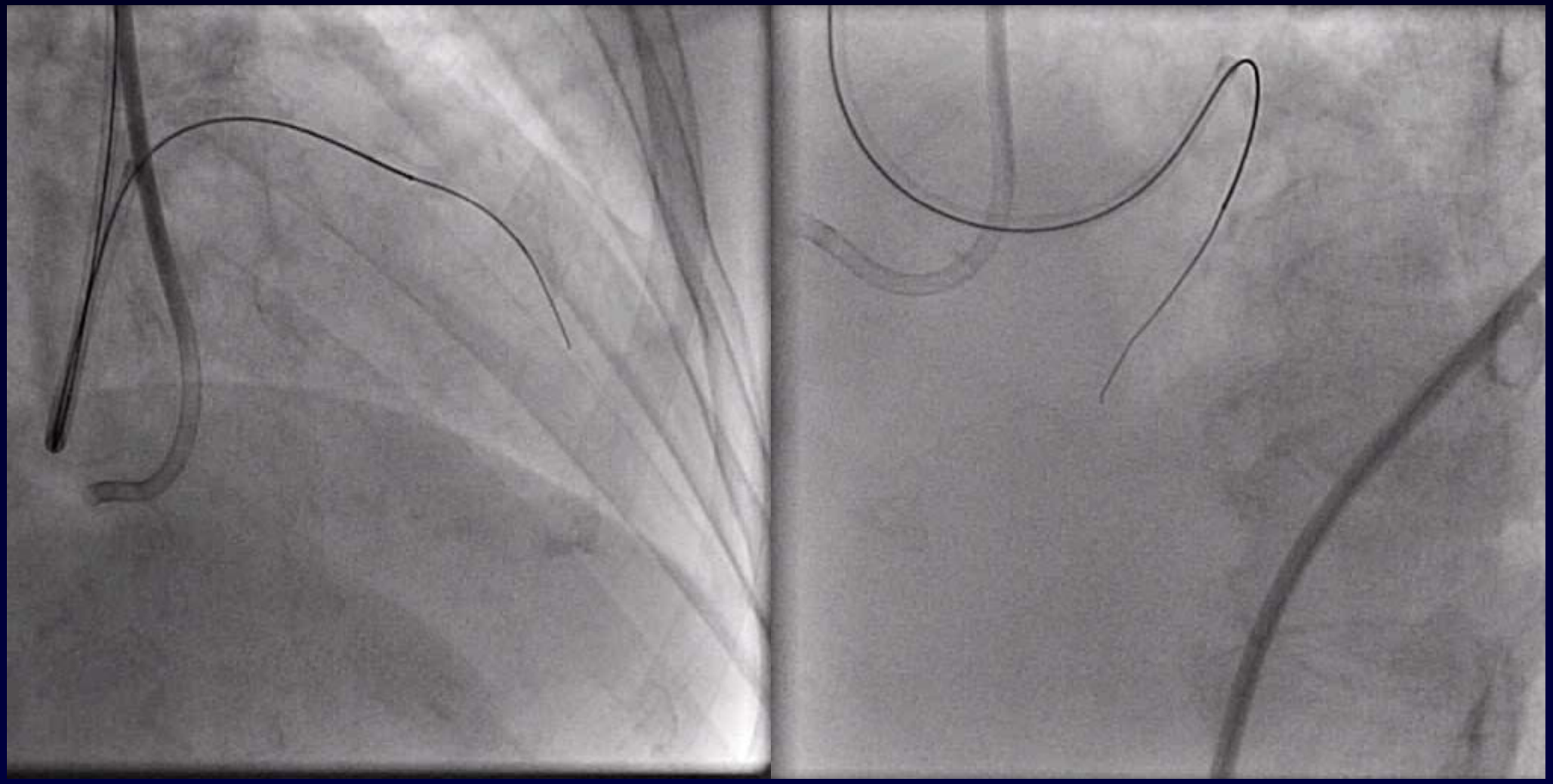
During angioplasty

Guide wire was inserted into Diagonal branch

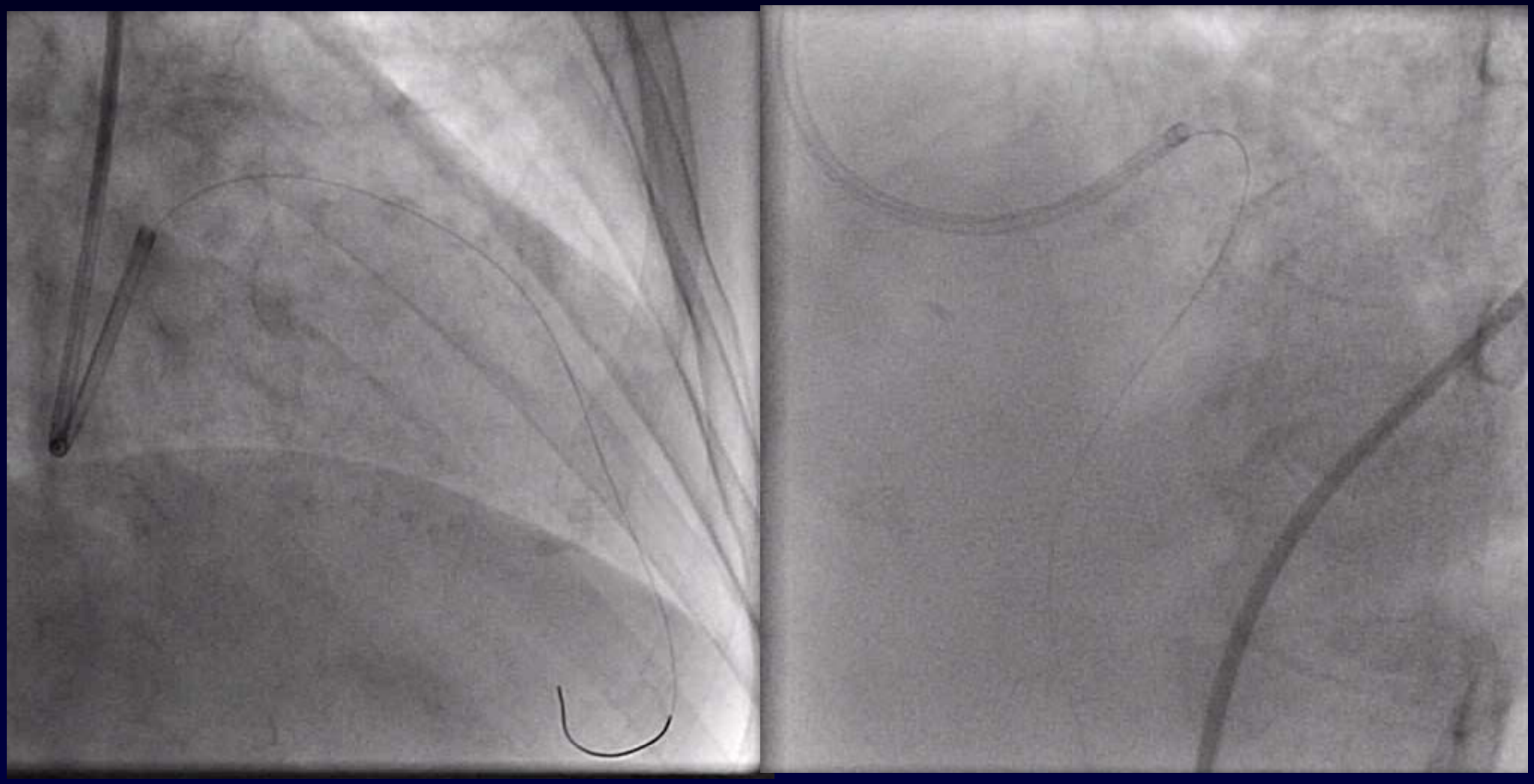


During angioplasty

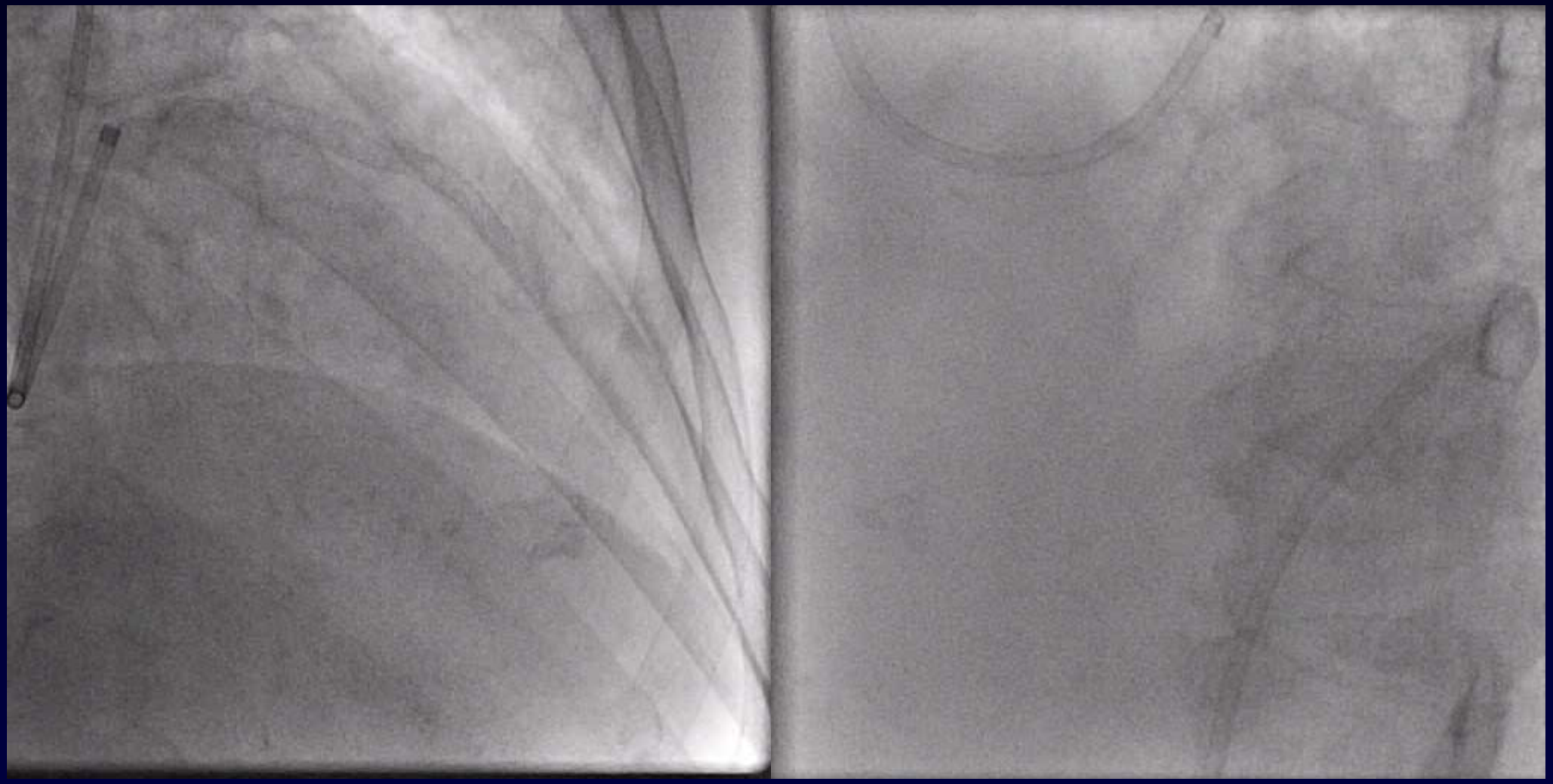
Guide wire was inserted into LAD



After balloon angioplasty



After stent implantaion



54 Year-old man

C.C Dyspnea for 1 week

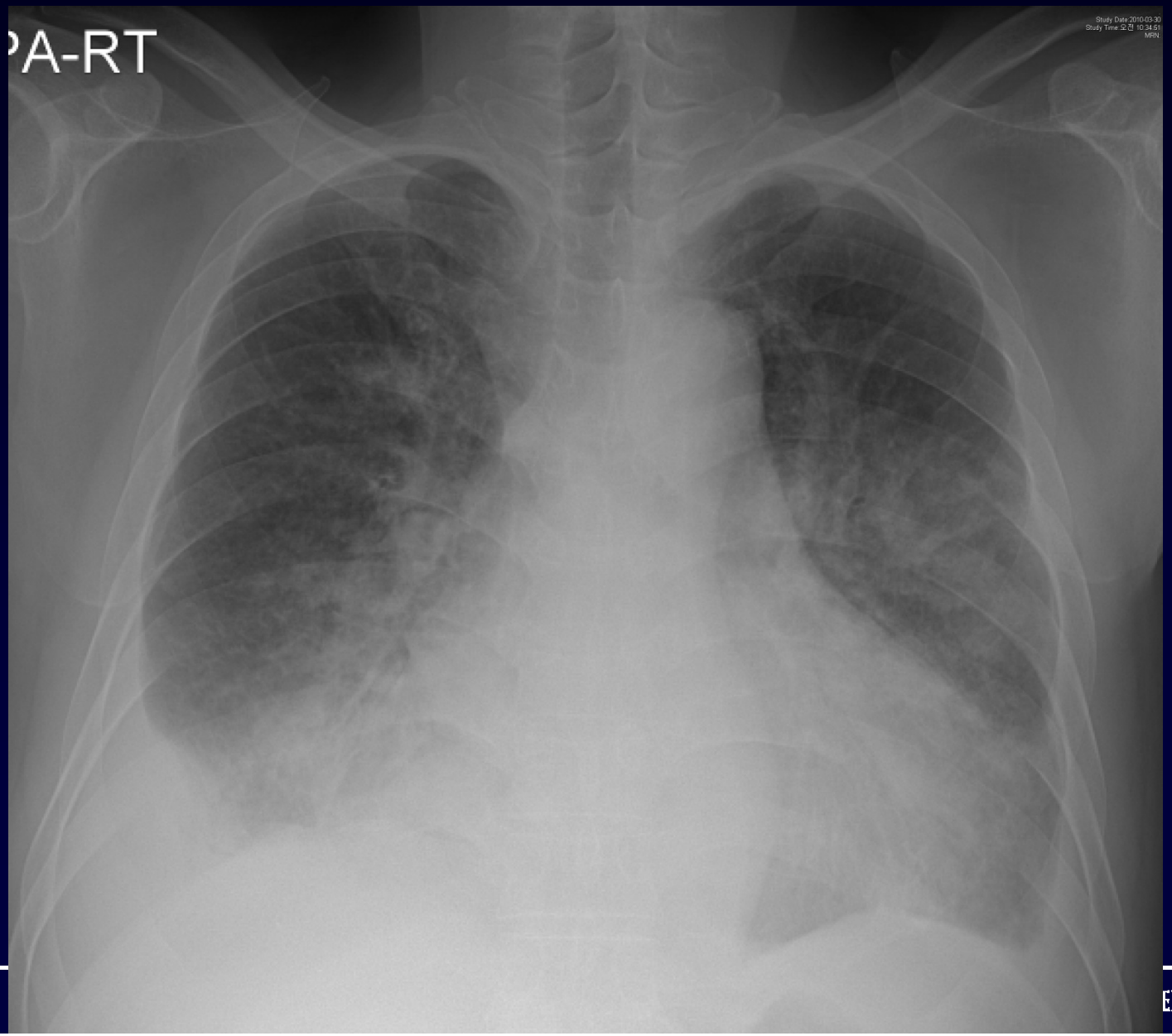
P.Hx Hypertension for 7 years
ESRD on CAPD for 1 year
CAOD 2-VD (dRCA & LAD-CTO):
diagnosed with angiography at 1 year ago

R.O.S Dyspnea (+)
Chest pain (-)
Fever/Cough/Sputum (+/+/+)

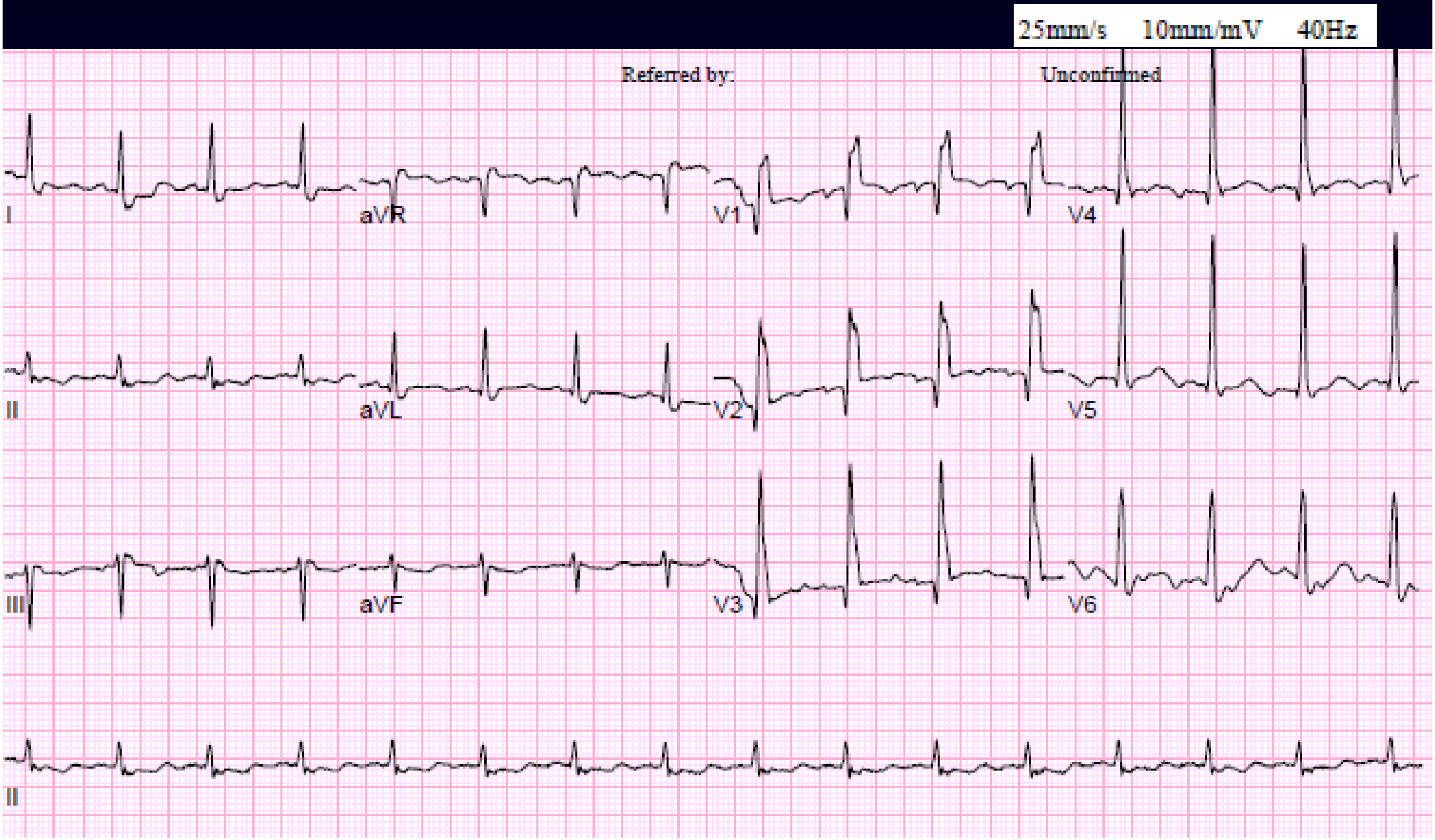
P.Ex V/S 100/50- 80 - 24 – 37.9
RHB without murmur
CBS with rale

 # 5508065

Chest PA



ECG


25mm/s 10mm/mV 40Hz
Referred by:
Unconfirmed
I
aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6
II

Lab finding

CBC 9670- 9.6/28.9- 243000

Chemistry Calcium: 8.5/ In-P: 5.2 (mg/dL)
Bun/Cr: 56.9/12.28 (mg/dL)
Cholesterol : 127 mg/dL
AST/ALT: 73/19 (IU/L)
CK/CK-MB: 710/94.23 (IU/L, ng/mL)
Tro-T: 2.91 (0~0.1 ng/mL)

aBGA 7.46-30.9/95.6-22.4-98.3%

 # 5508065

Echocardiography

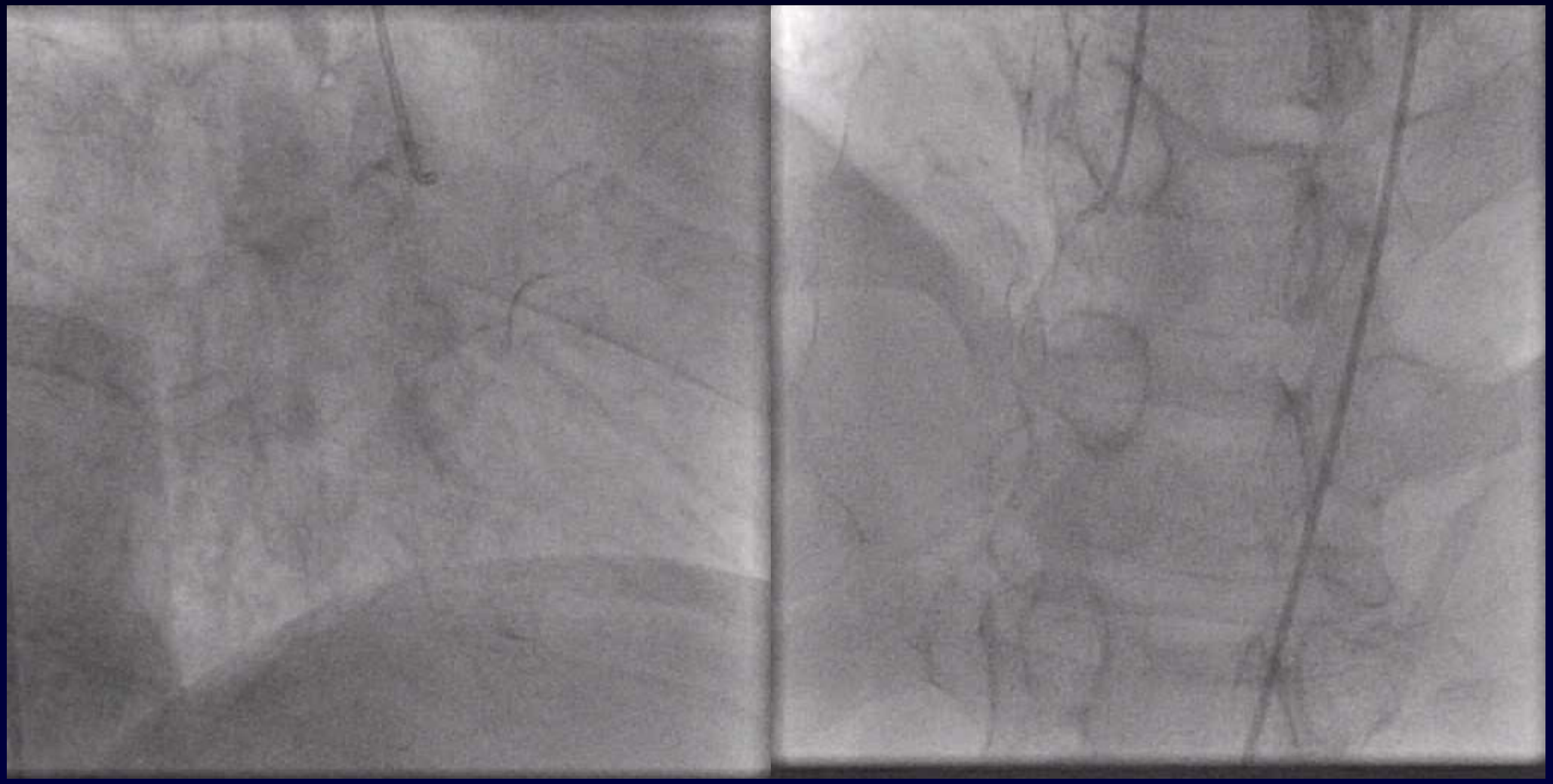
2009-02-19 → **2010-03-30**

- RWMA: LAD territory
- LVEDD: 58mm, LAVI 26 ml/m^2
- EF: 39%

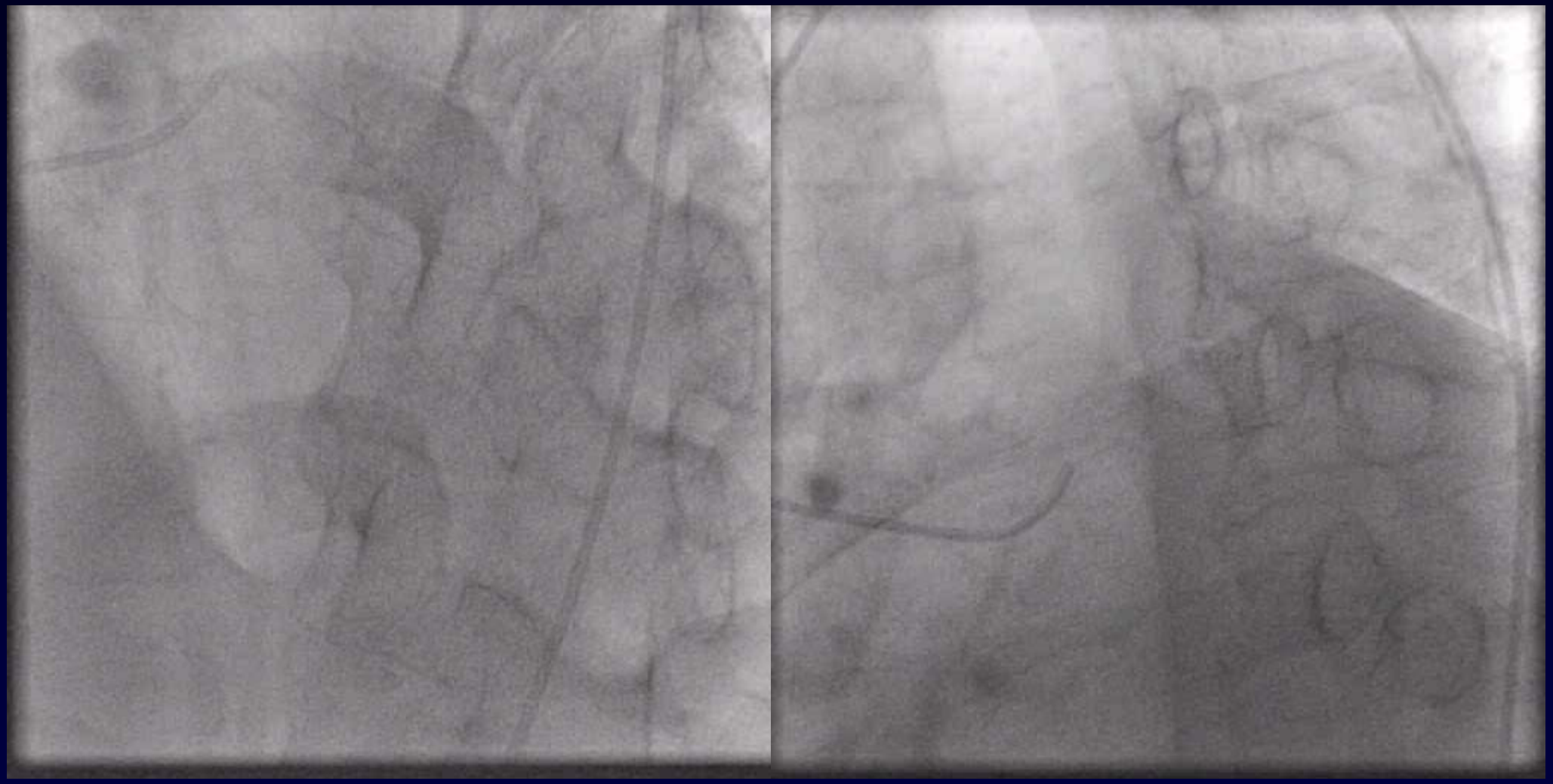
- RWMA: LAD and RCA territory
- LVEDD: 65mm, LAVI: 38 ml/m^2
- EF: 29%

Initial angiography (RCA)

2010-04-02



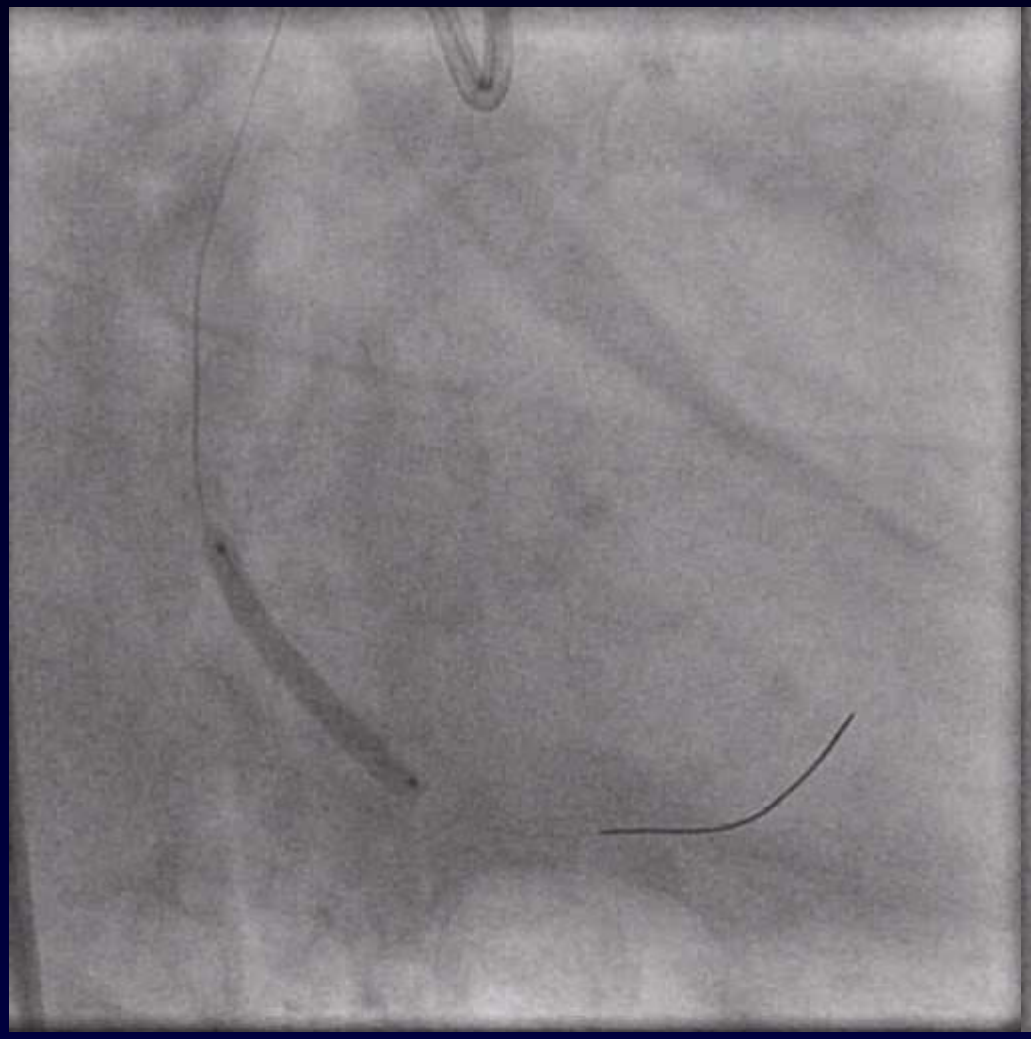
Initial angiography (LCA)

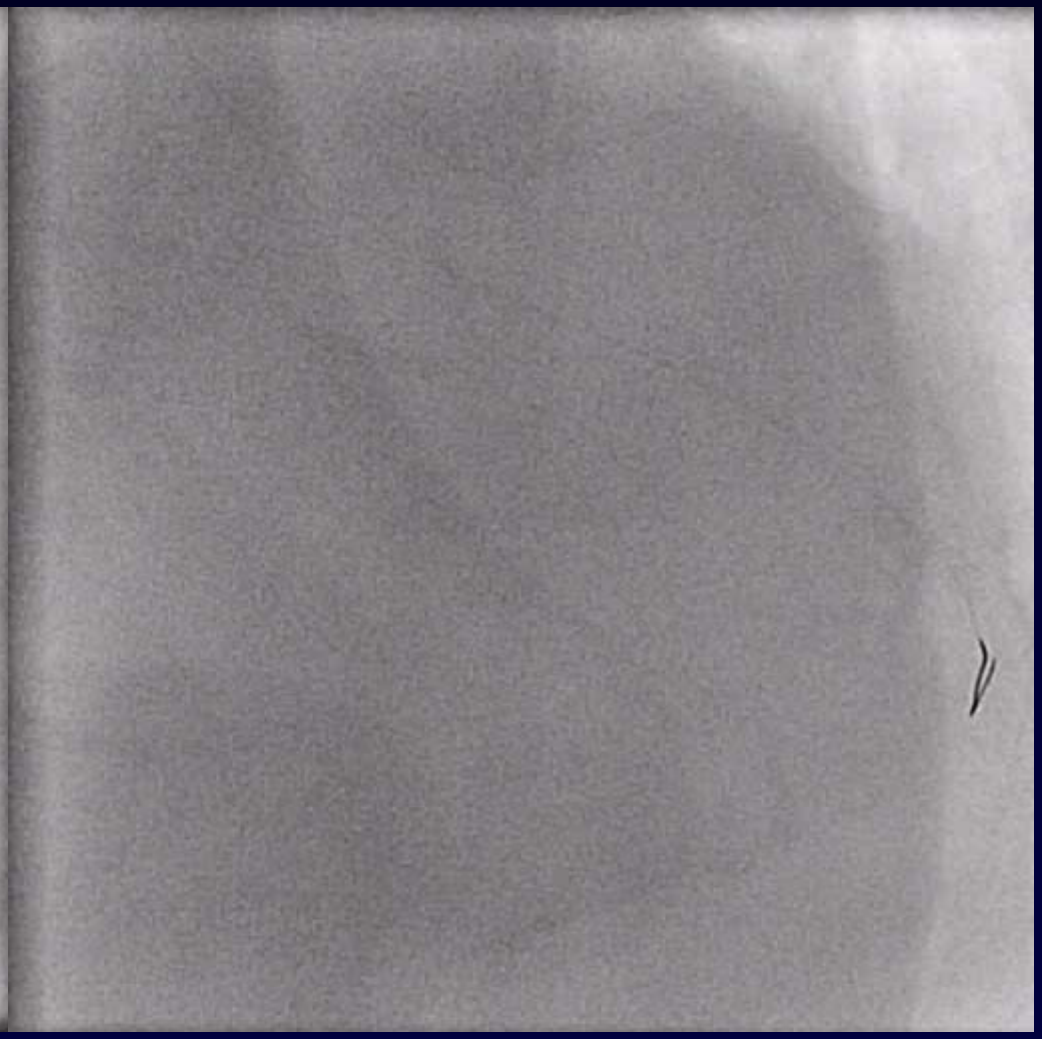


RCA angioplasty

Endeavor resolute 2.75x30

After stent deployed

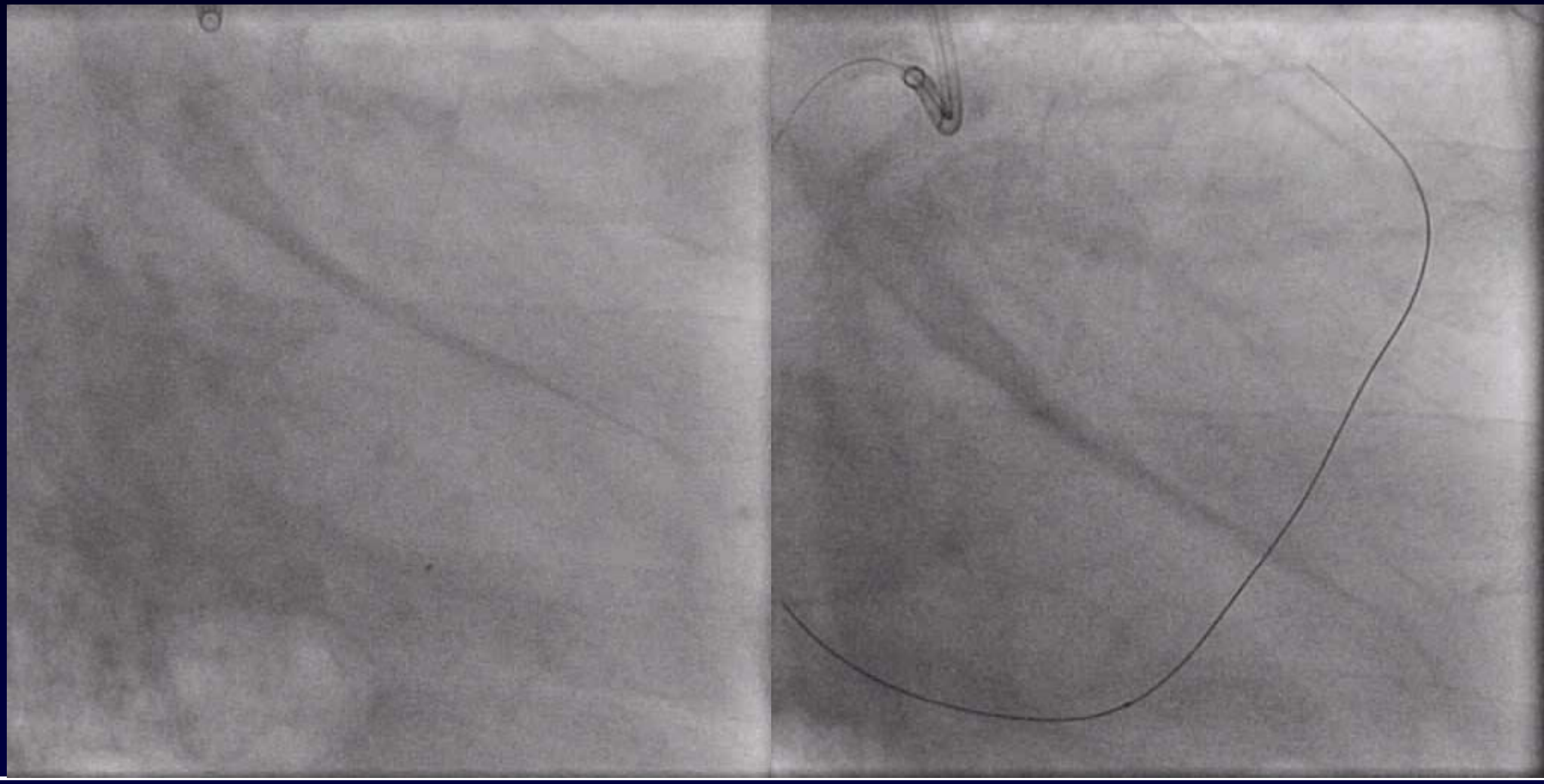




Retrograde approach (RAO-cranial view)

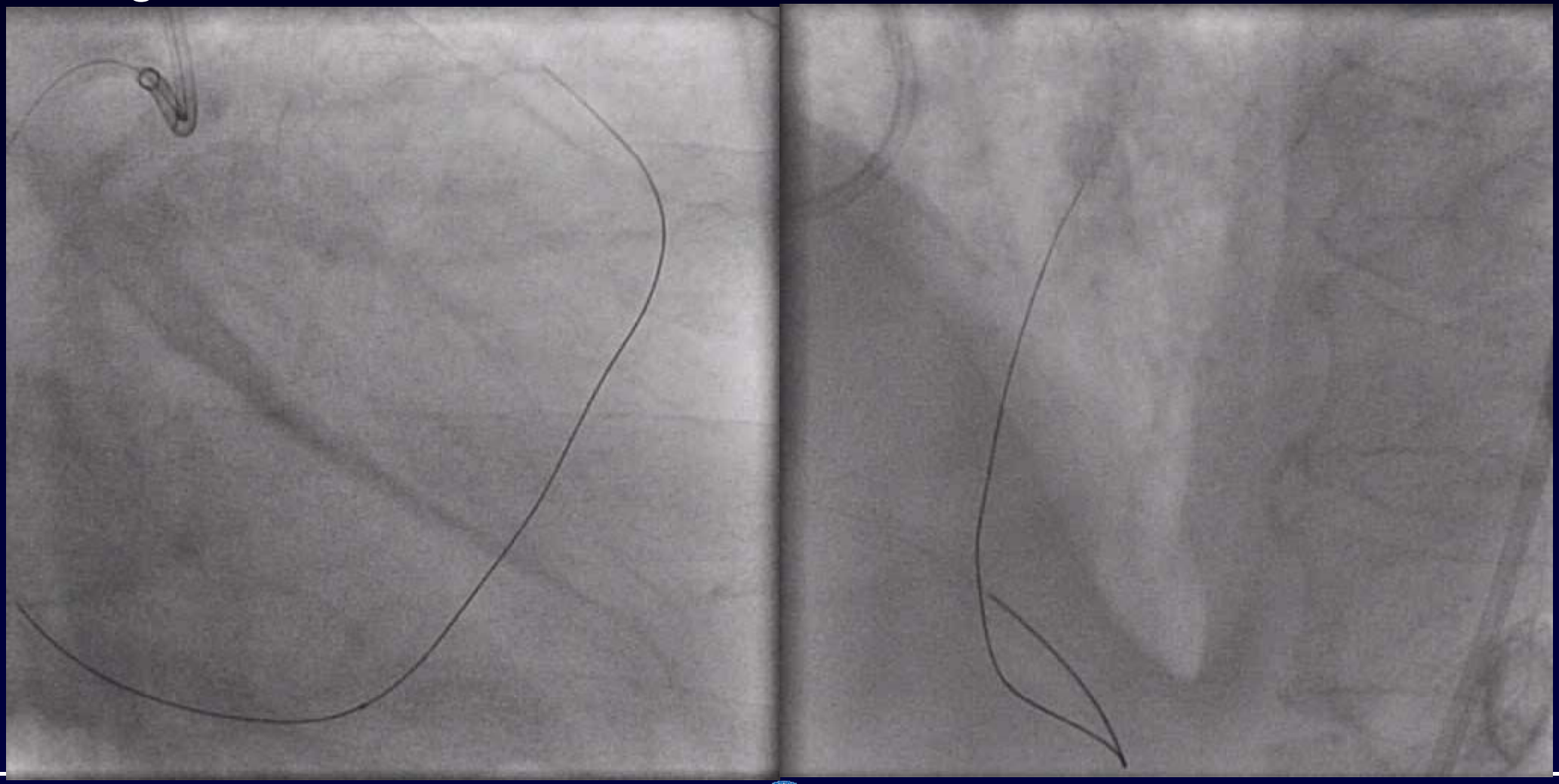
Microcatheter angiography

Wire passed into the LAD through collaterals



Retrograde approach

A wire with microcatheter couldn't reach to the pLAD d/t long length of collaterals



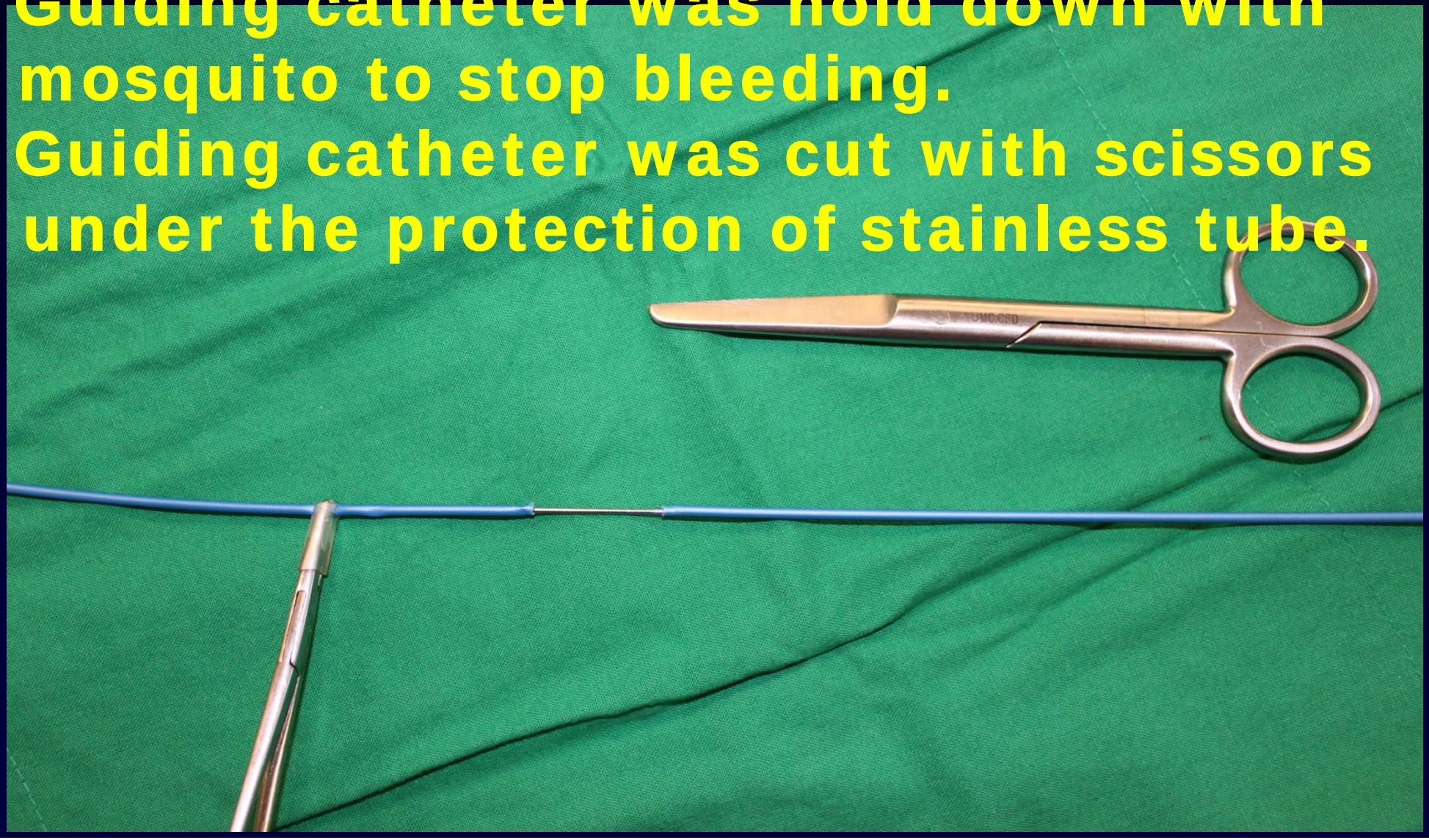
Retrograde Approach

Medtronic Guiding

1. GW was not able to reach Lt Main due to big heart and long collateral pathway.
2. Guiding Catheter preparation-Protection of GW with stainless steal tube

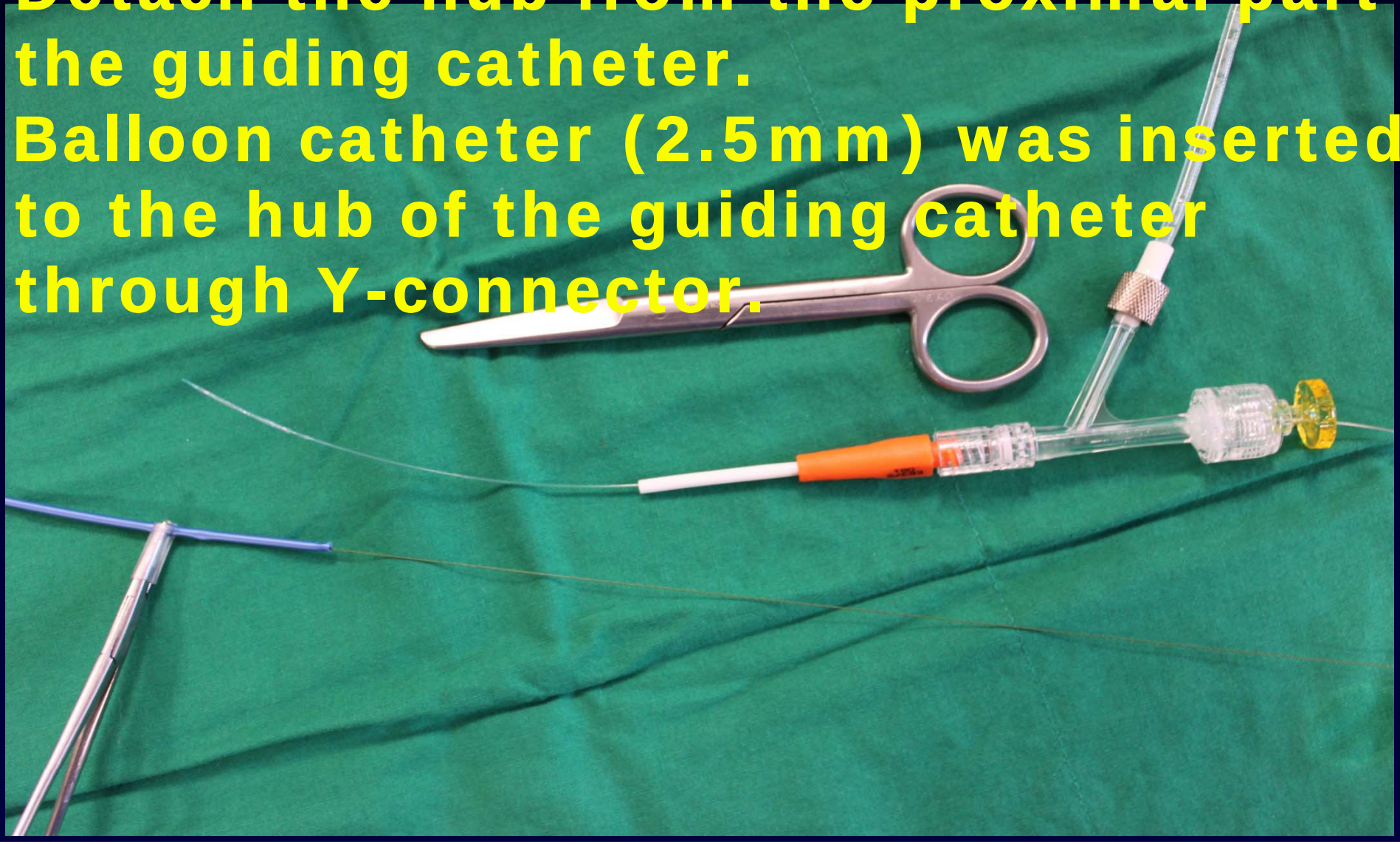
Retrograde Approach

1. Guiding catheter was hold down with mosquito to stop bleeding.
2. Guiding catheter was cut with scissors under the protection of stainless tube.



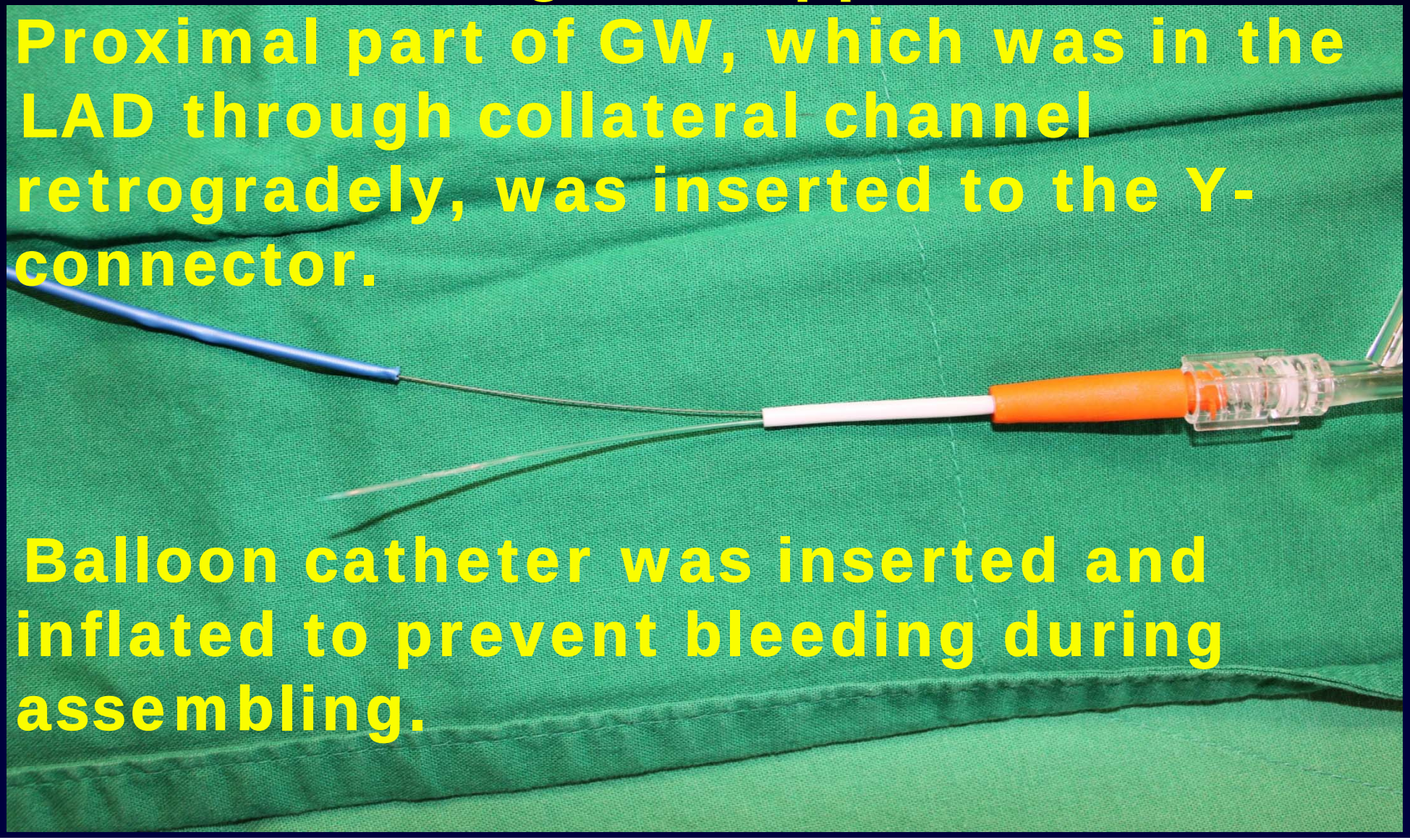
Retrograde Approach

1. Detach the hub from the proximal part of the guiding catheter.
2. Balloon catheter (2.5mm) was inserted to the hub of the guiding catheter through Y-connector.



Retrograde Approach

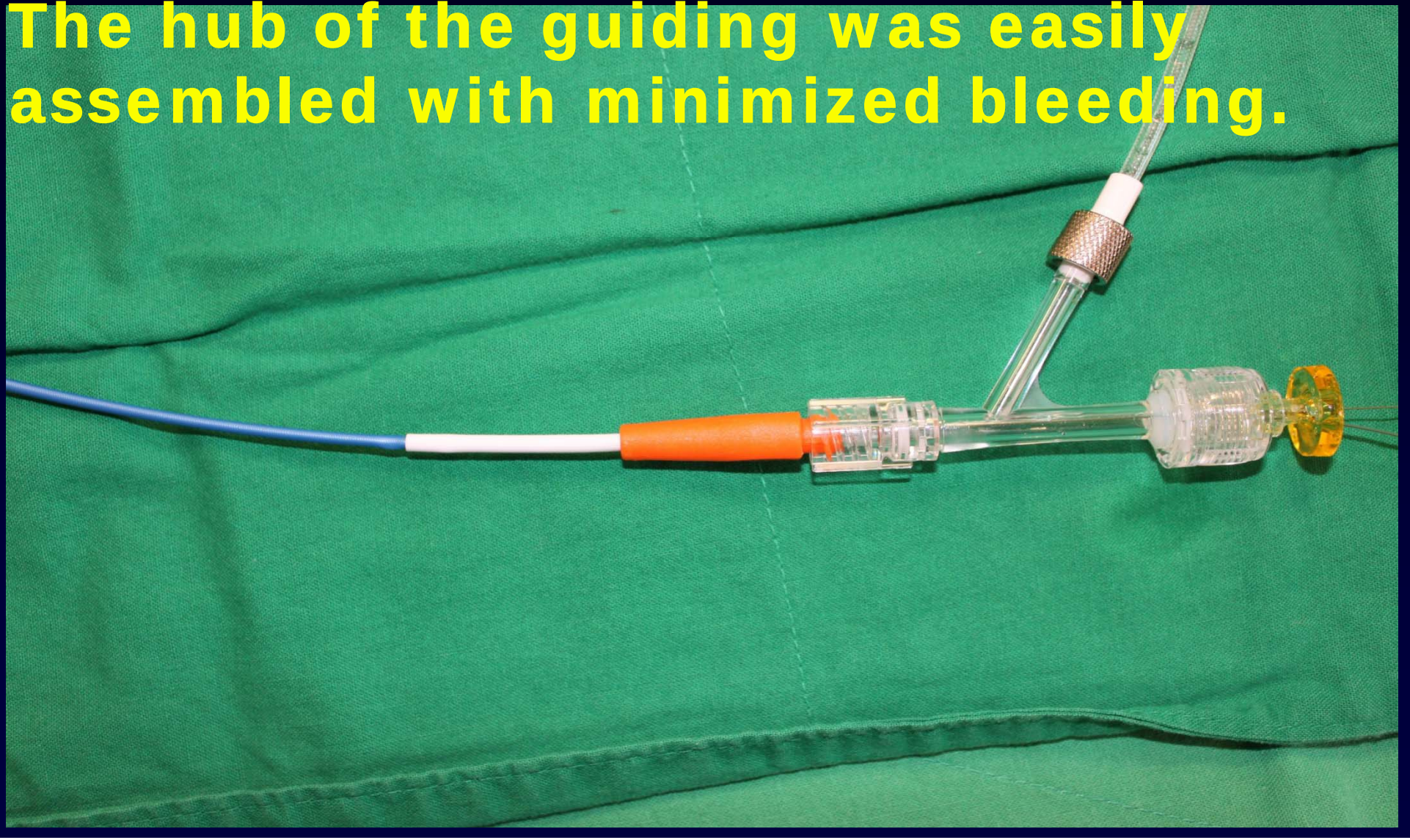
1. Proximal part of GW, which was in the LAD through collateral channel retrogradely, was inserted to the Y-connector.



2. Balloon catheter was inserted and inflated to prevent bleeding during assembling.

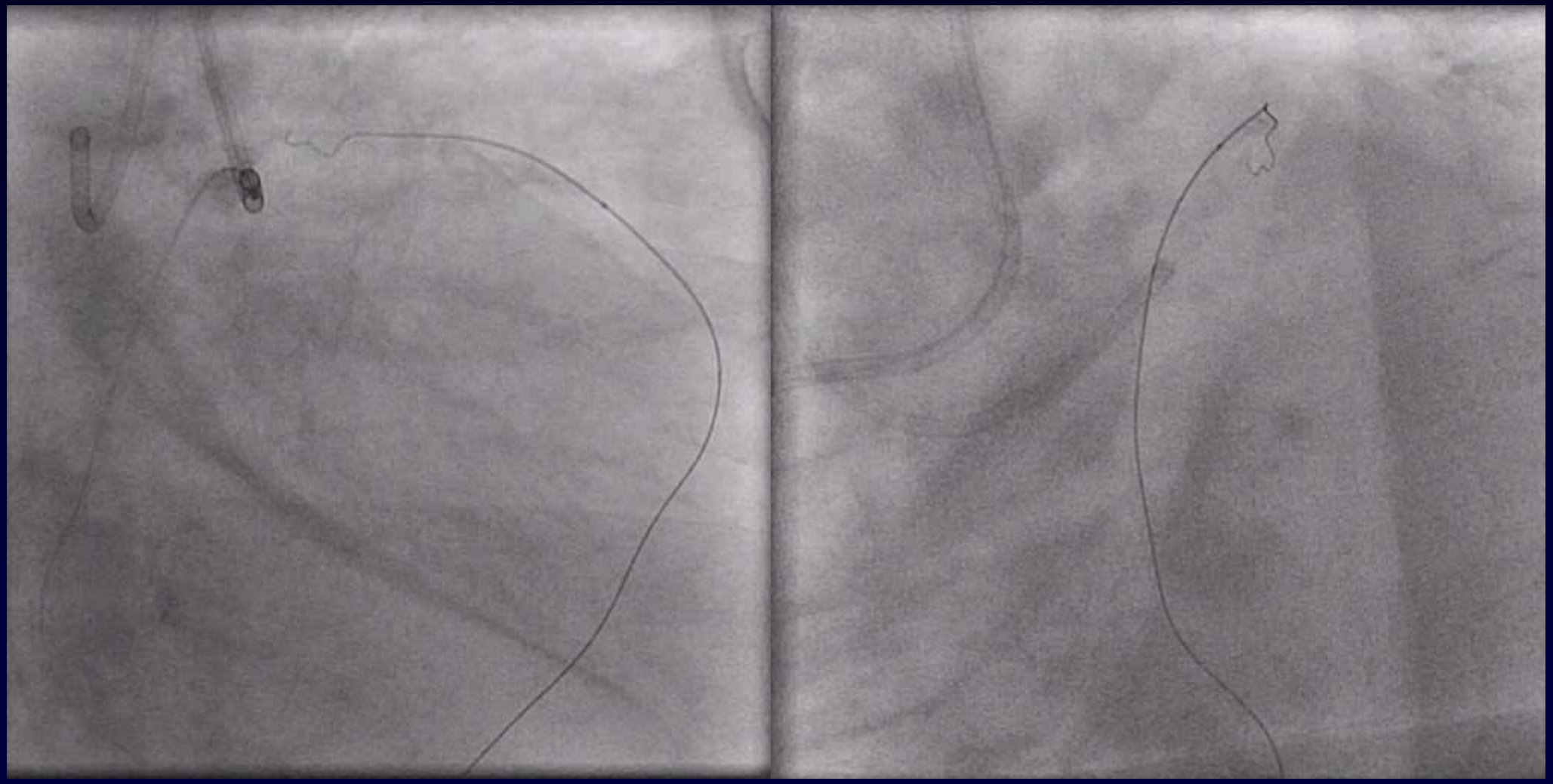
Retrograde Approach

1. The hub of the guiding was easily assembled with minimized bleeding.



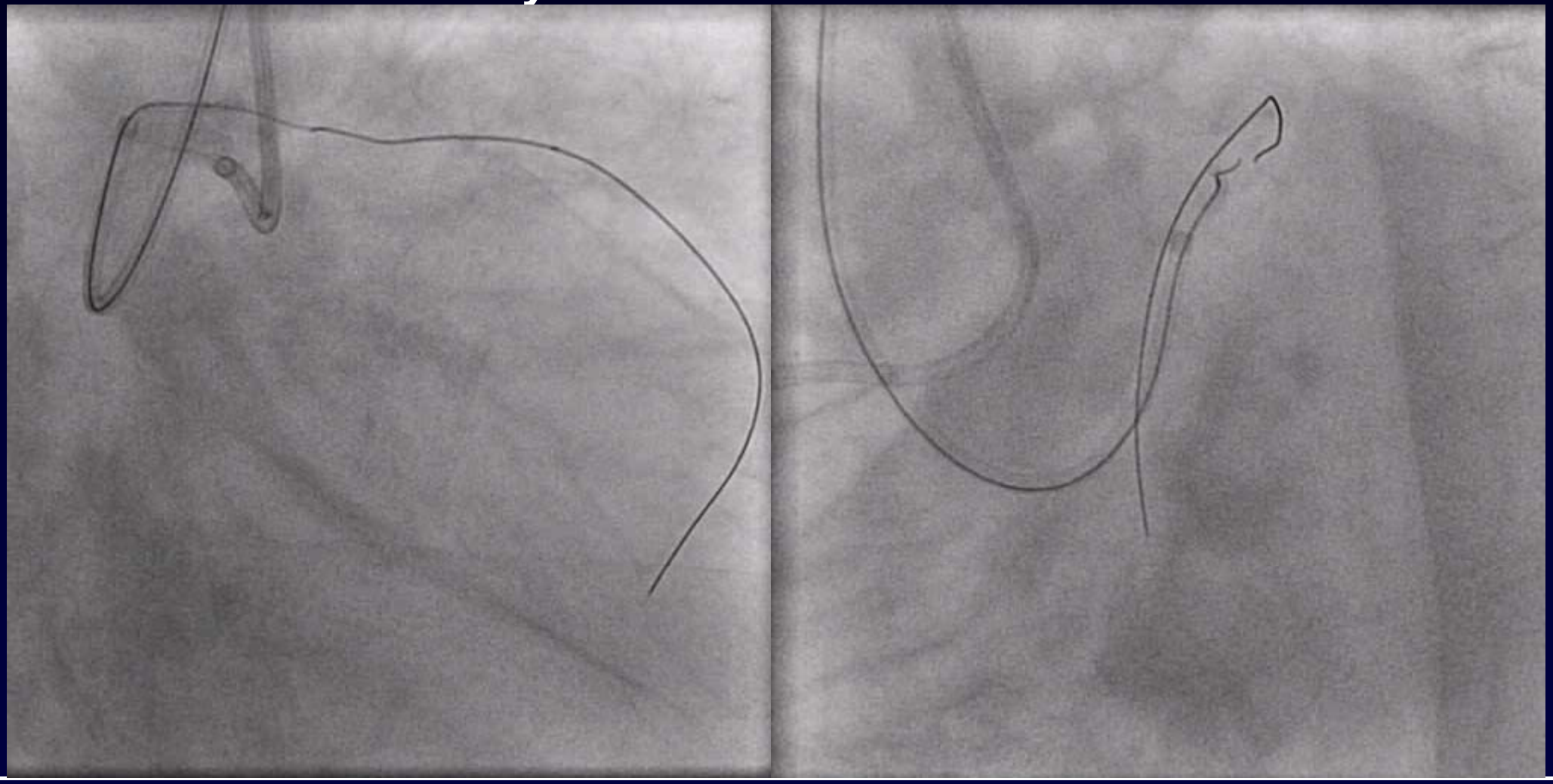
Retrograde approach

The enough length was secured for retrograde approach



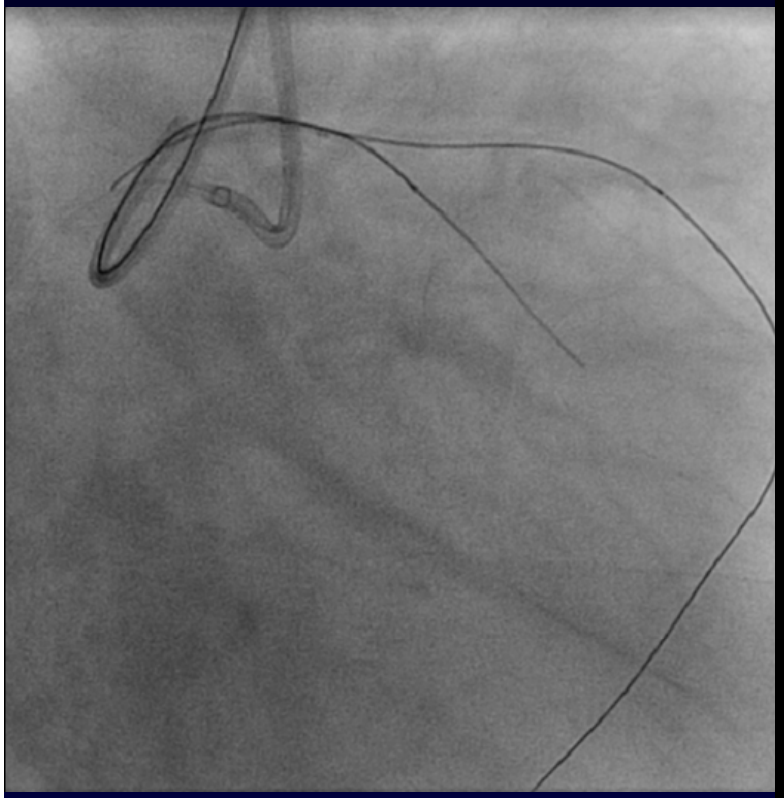
Bilateral approach

The several types of G/W were attempted to entering at tough CTO lesion bilaterally.

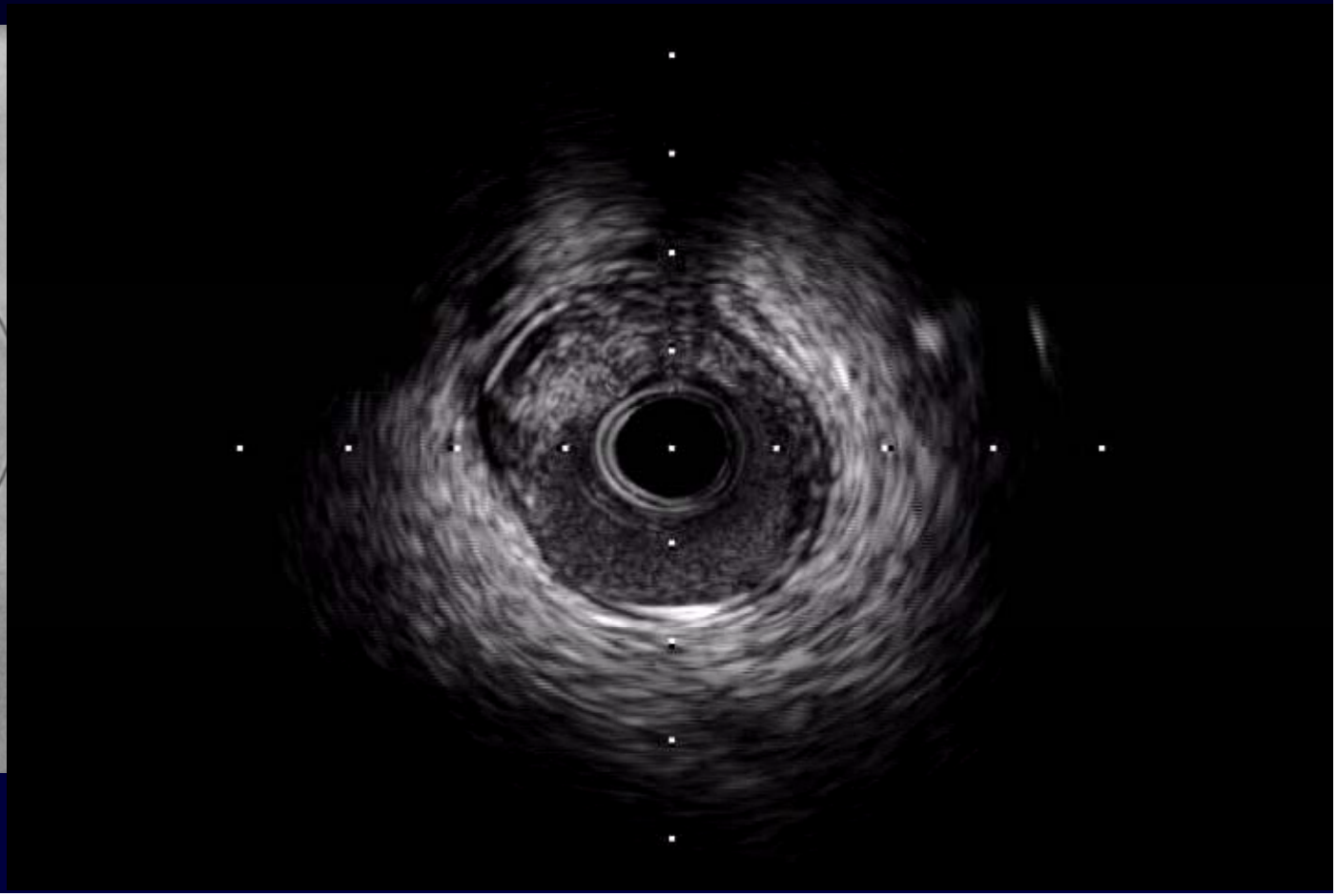


IVUS finding (intermedius br.)

After retro-G/W passed to the main coronary a.

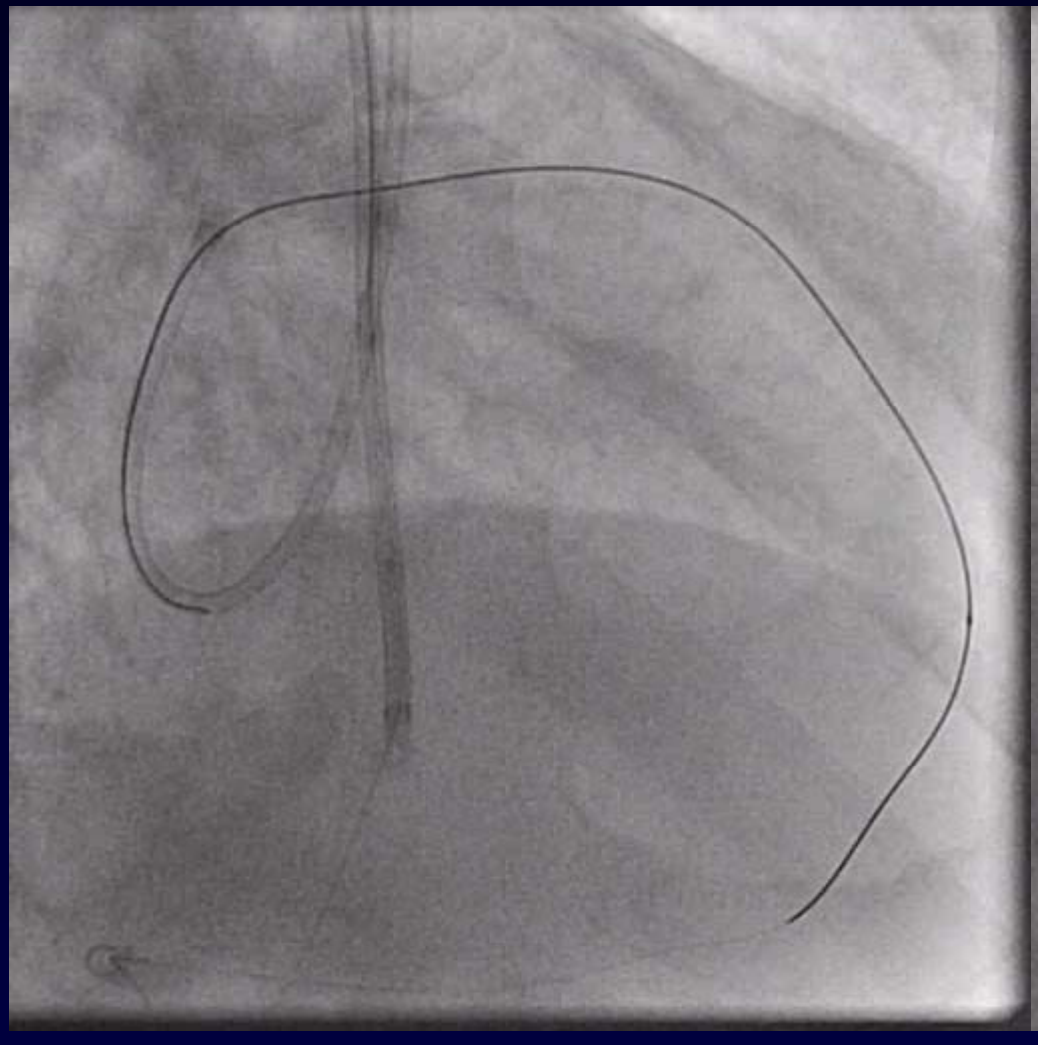


Eccentric plaque noted from opposite direction to LAD, LCX

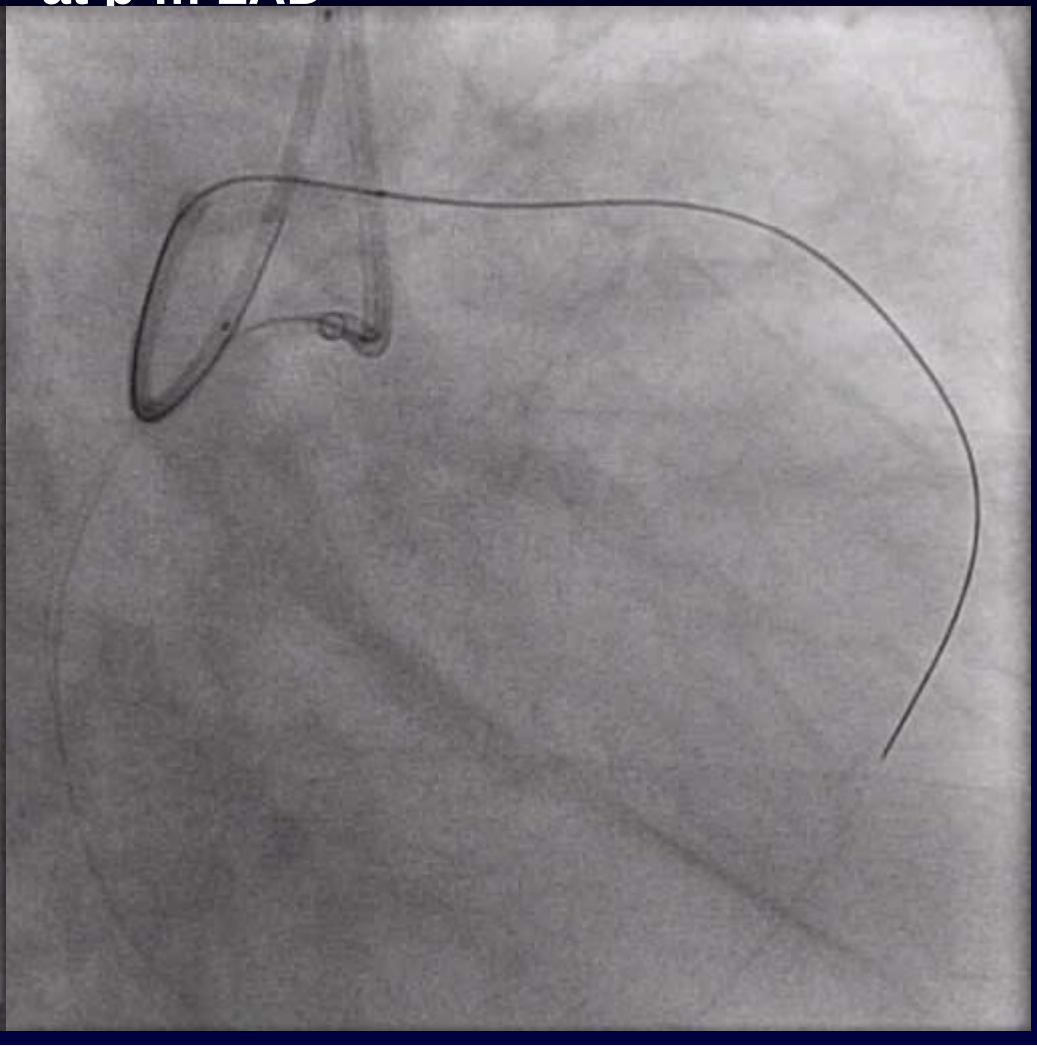


Bilateral approach

G/W with microcathter successfully entered into a LCA catheter

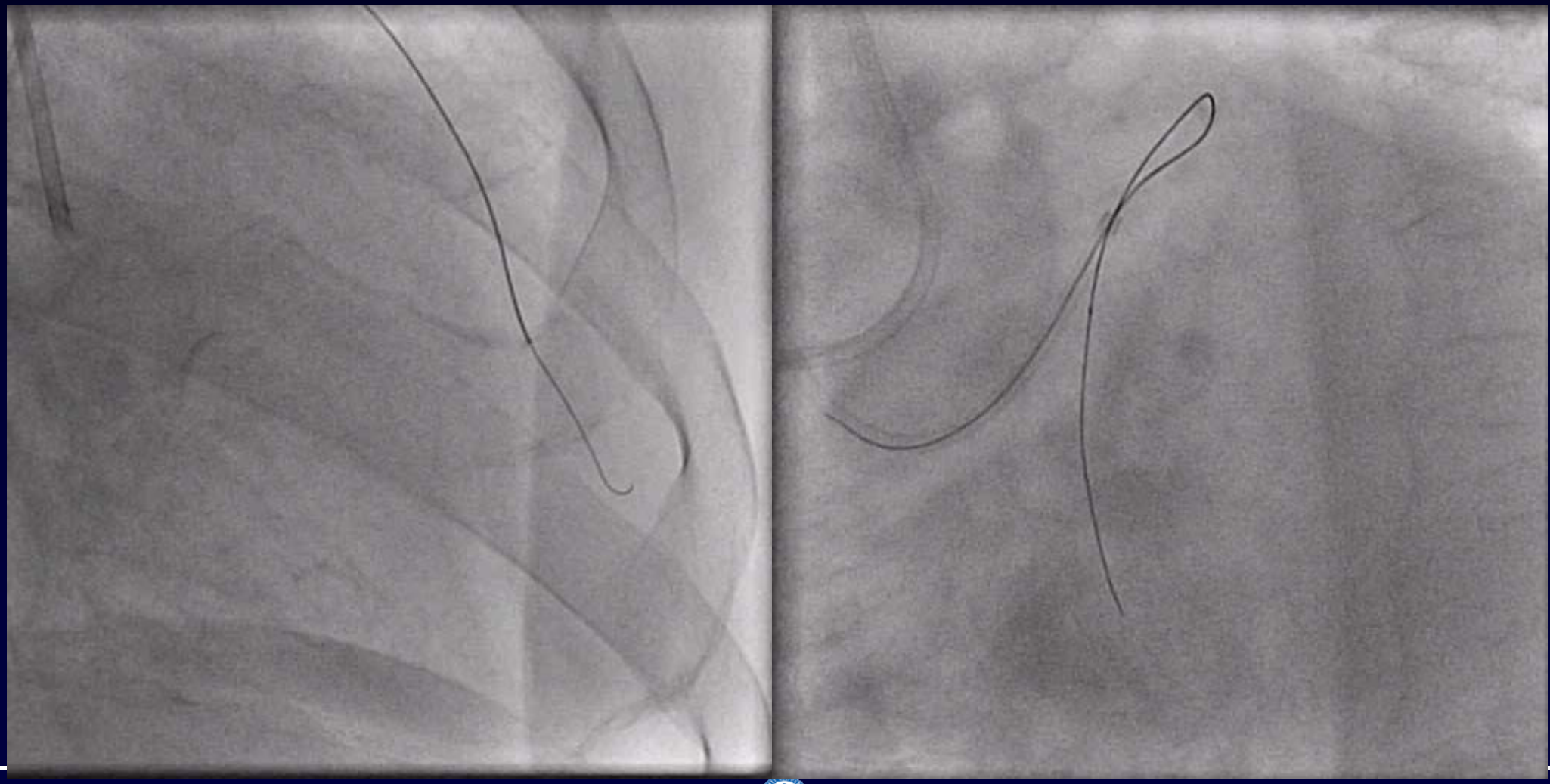


1.5x15 balloon -> 2.5x15 balloon at p-m LAD



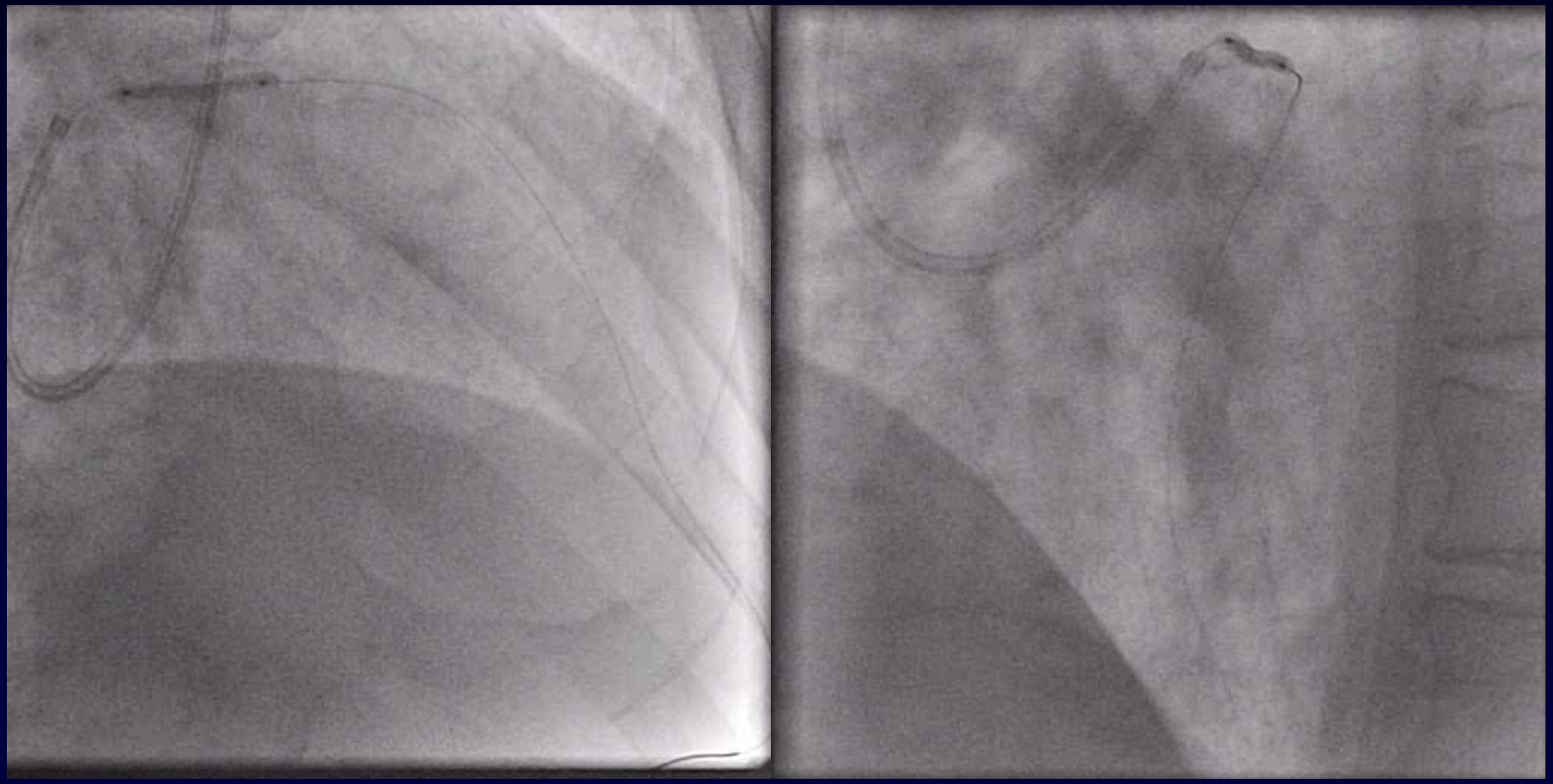
Antegrade approach

Then, the G/W with microcathter was successfully entered into the LAD with antegrade approach



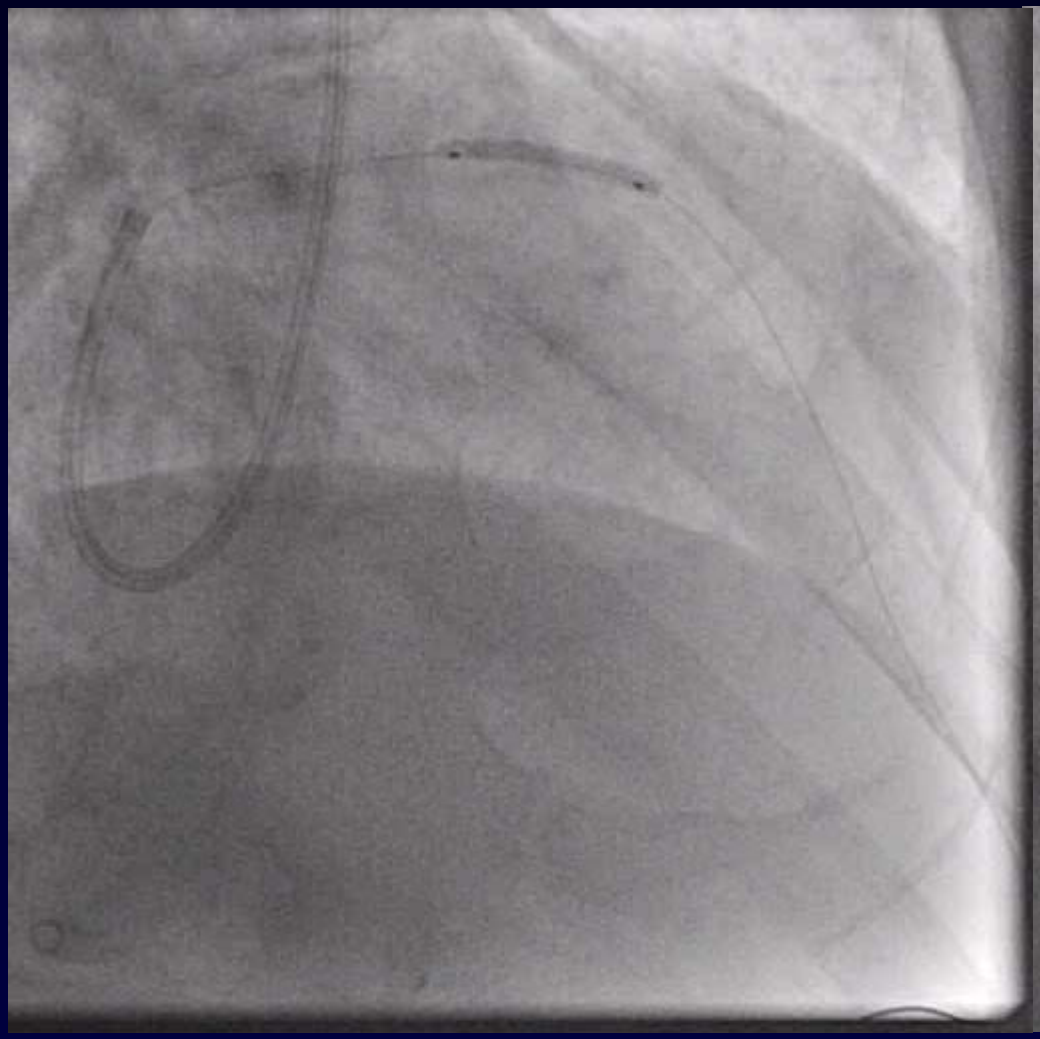
Antegrade angioplasty

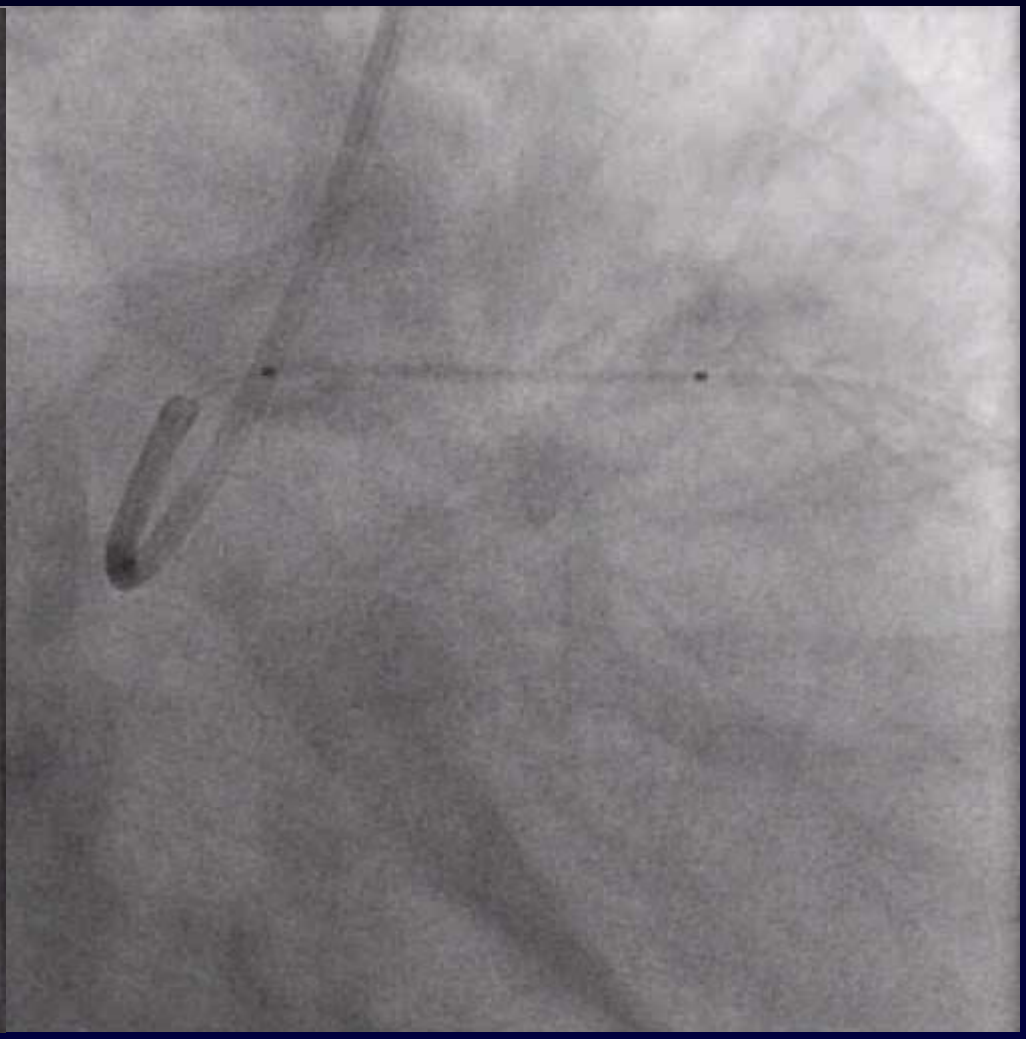
2.5x15 balloon 8atm/10sec at p-m LAD several times



Antegrade angioplasty

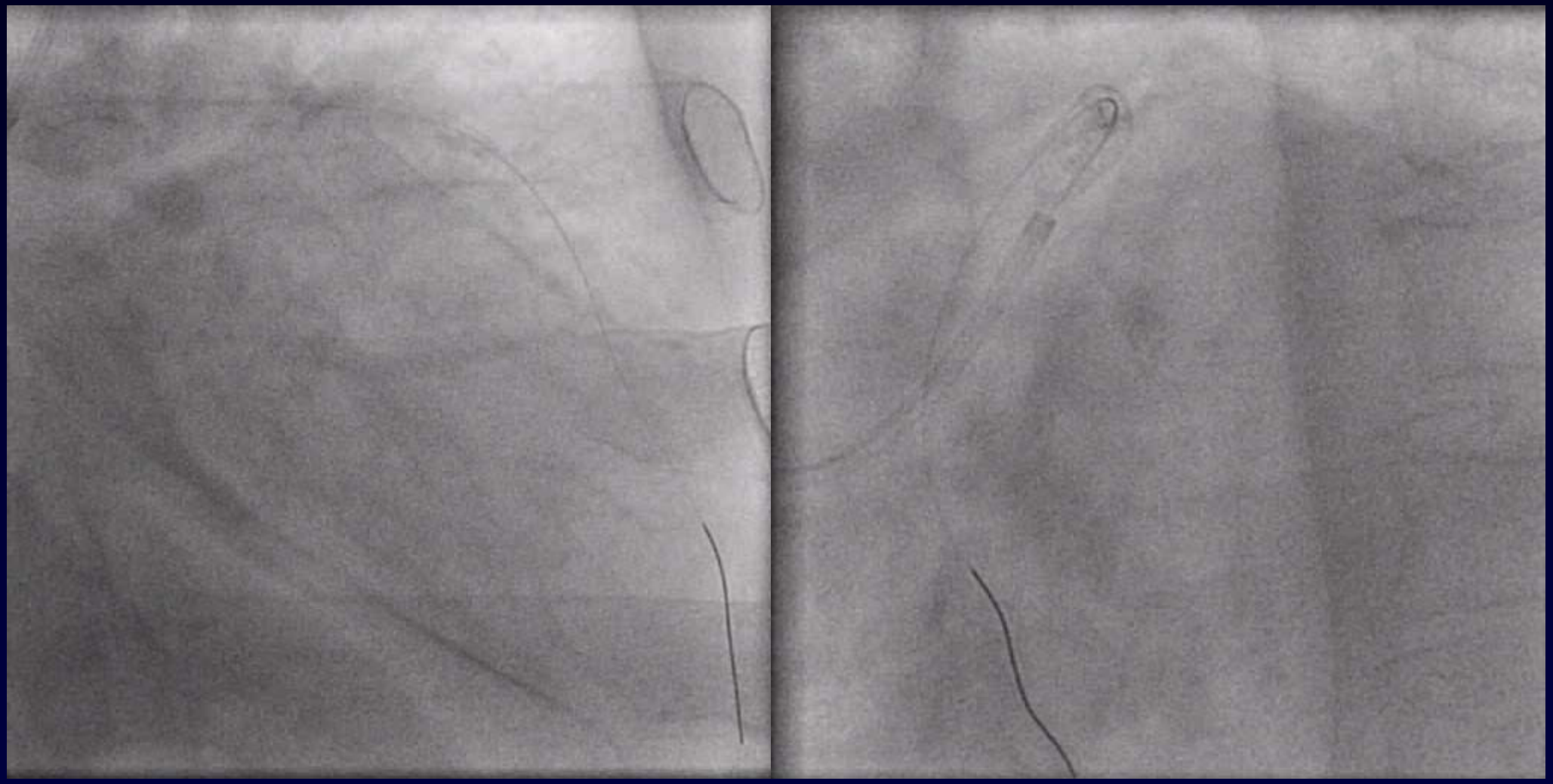
Endeavor R 2.5x30 at mLAD, 2.75x18 at pLAD





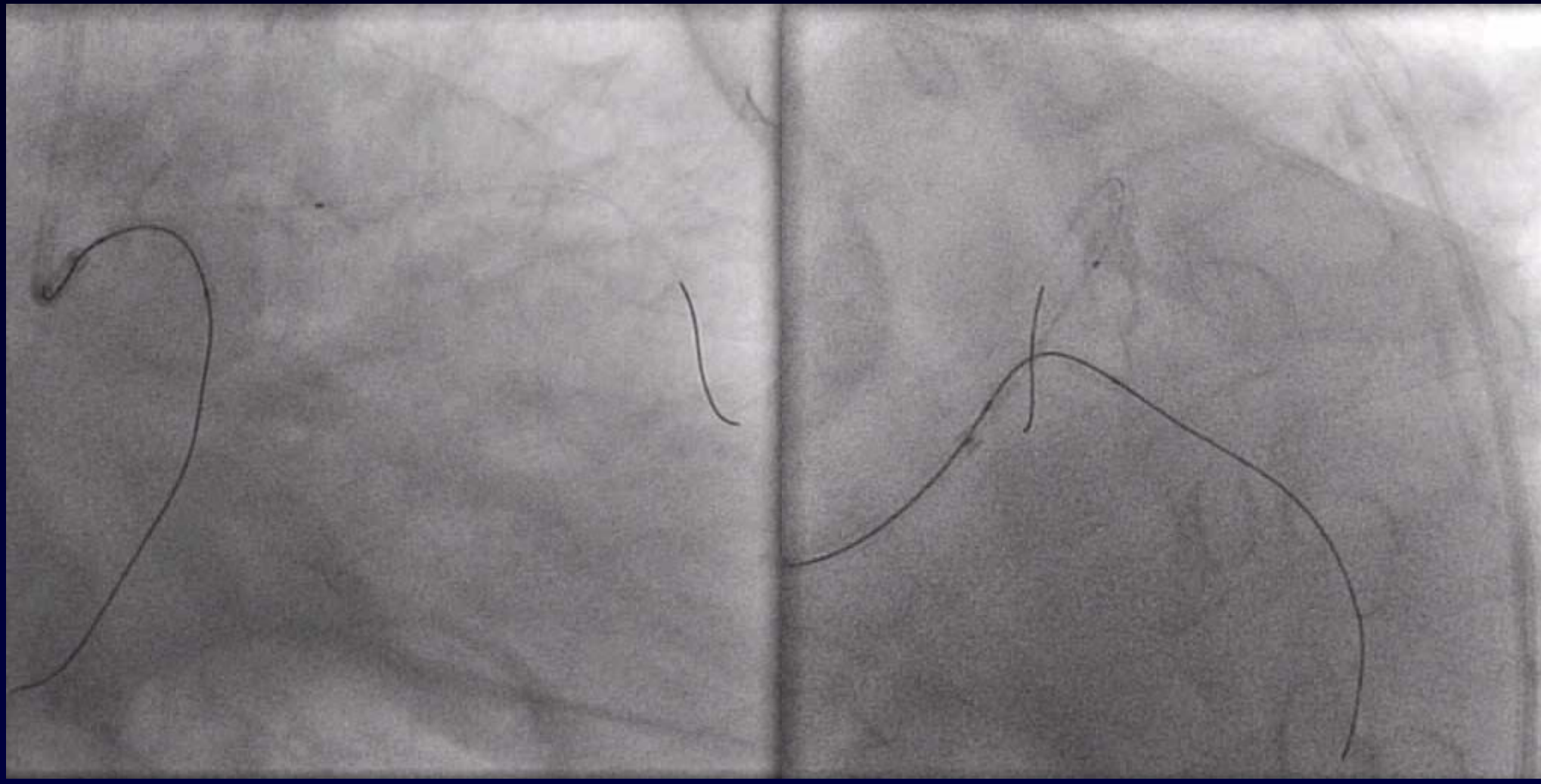
Antegrade angioplasty

LCX br. was jailed after LAD stenting



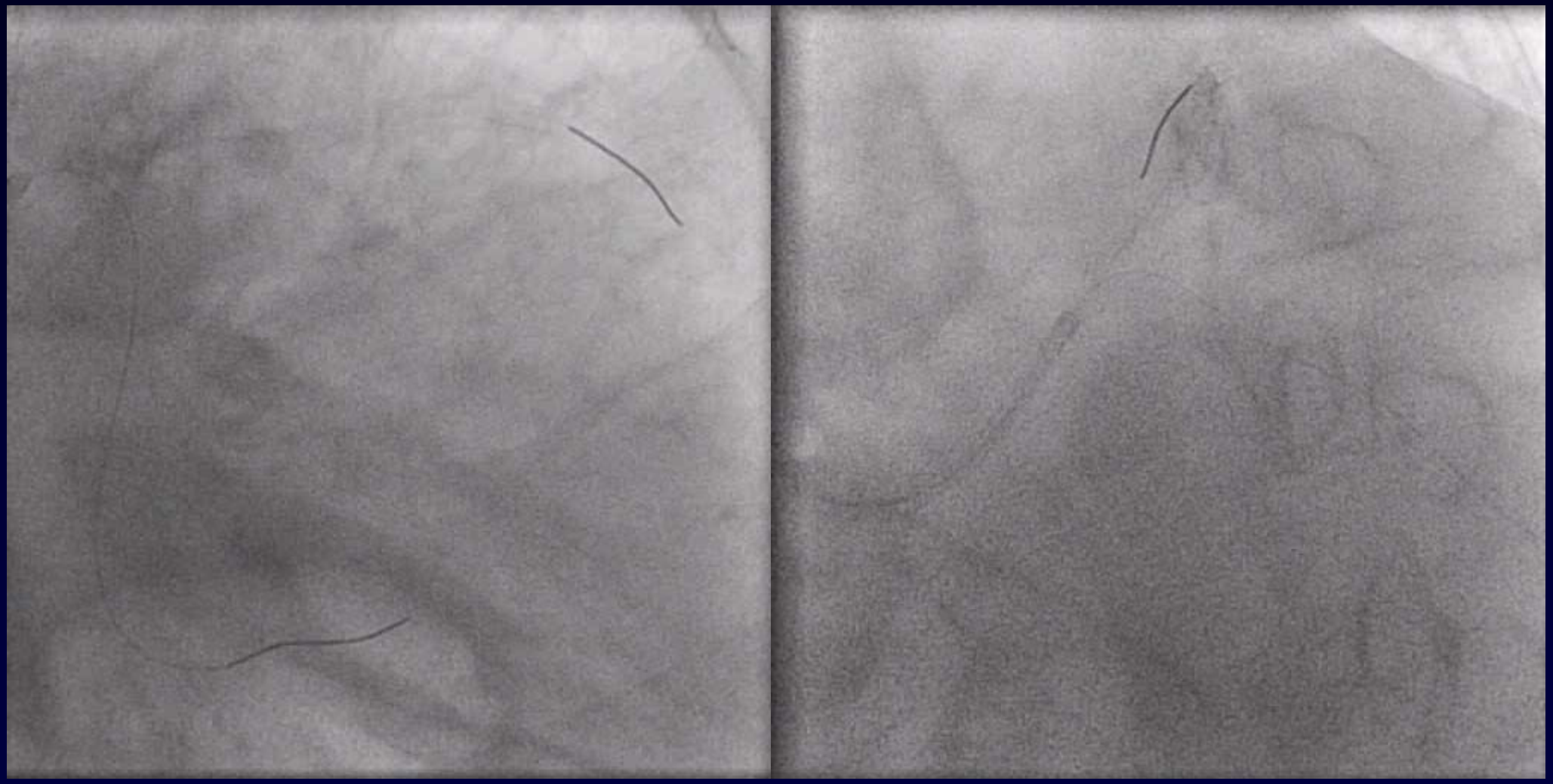
Antegrade angioplasty

Kissing balloon with 2.5x15 at pLAD, 1.5x15 at LCX was done



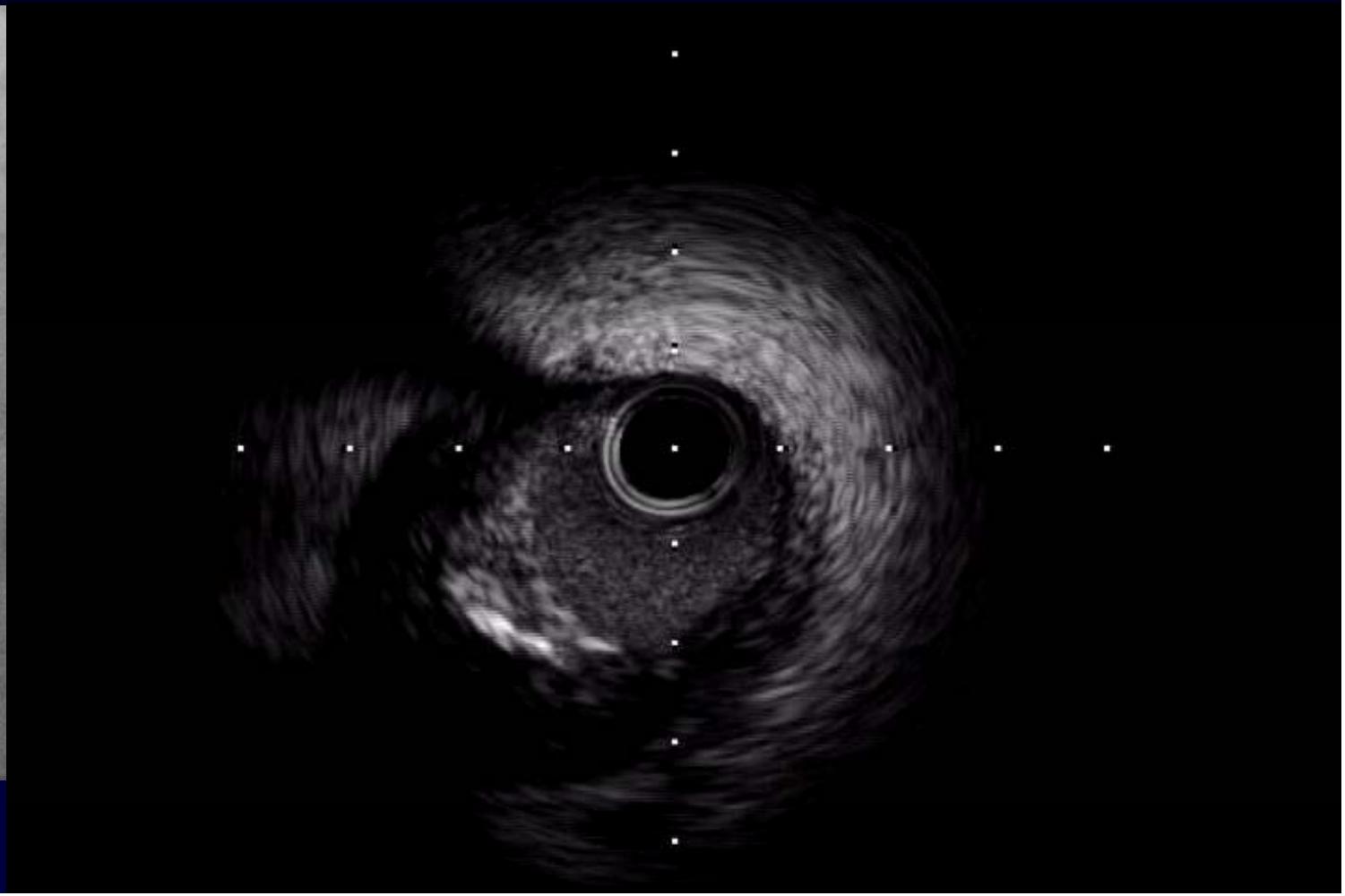
Antegrade angioplasty

Intermedius br. Flow was suddenly disappeared after LCX ballooning



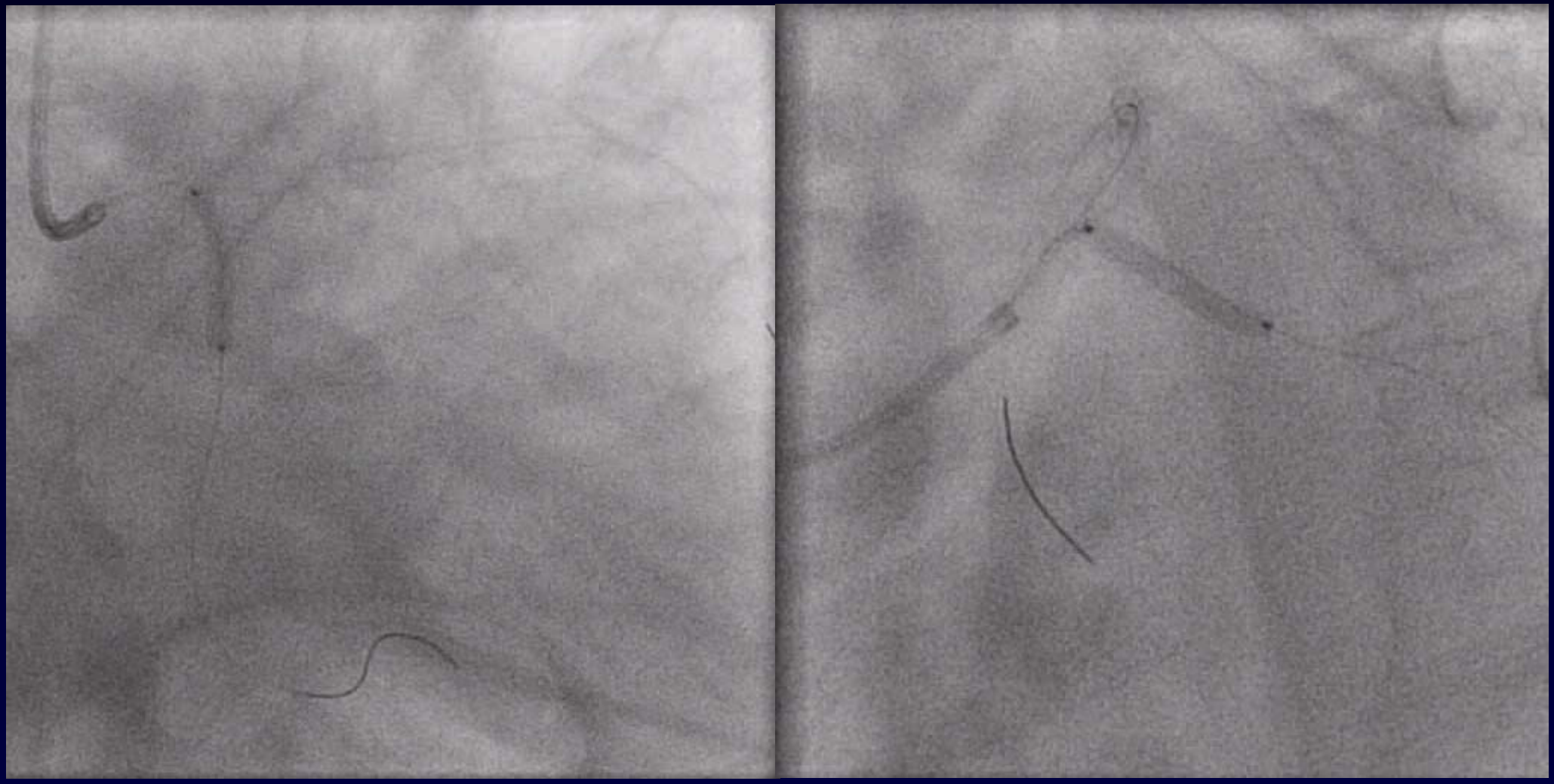
IVUS (LCX)

LCX plaque also located at opposite direction of LAD bifurcation site



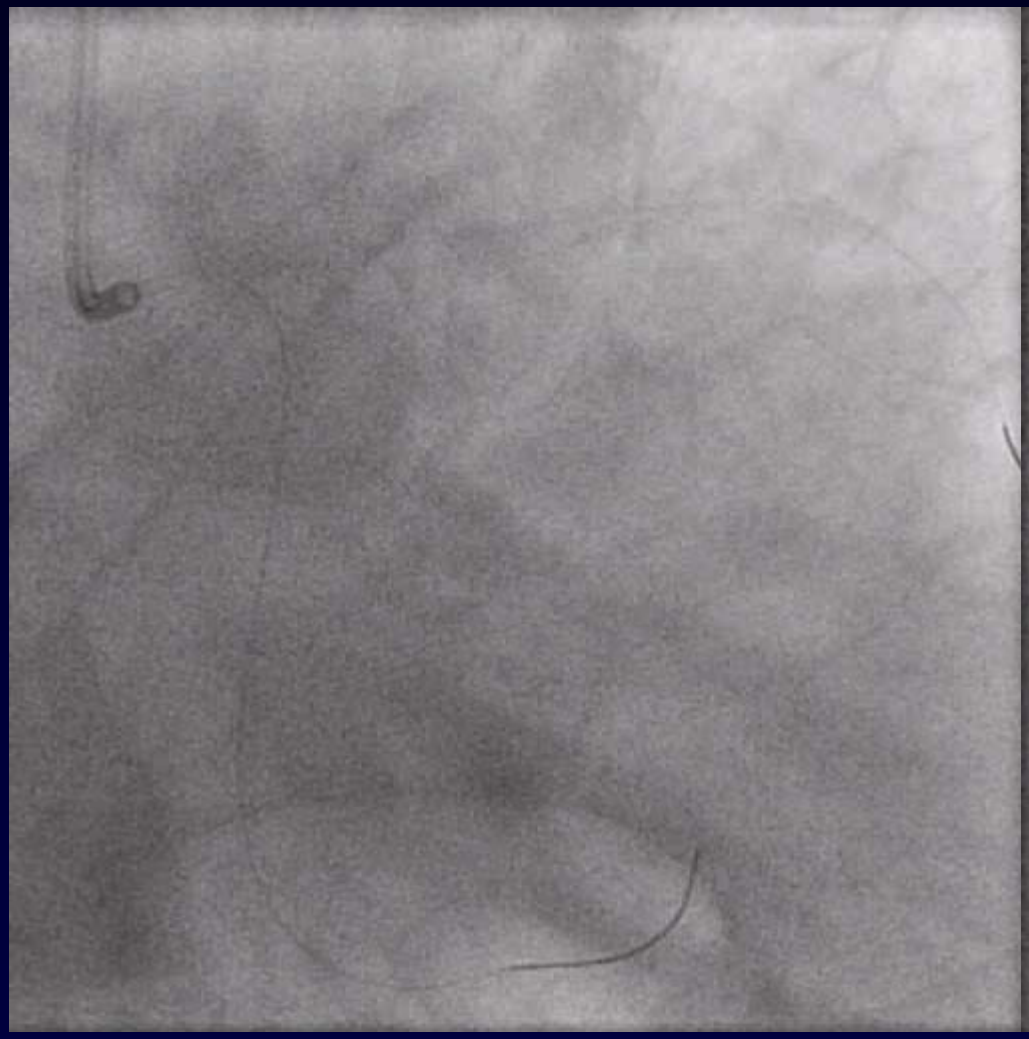
Antegrade angioplasty

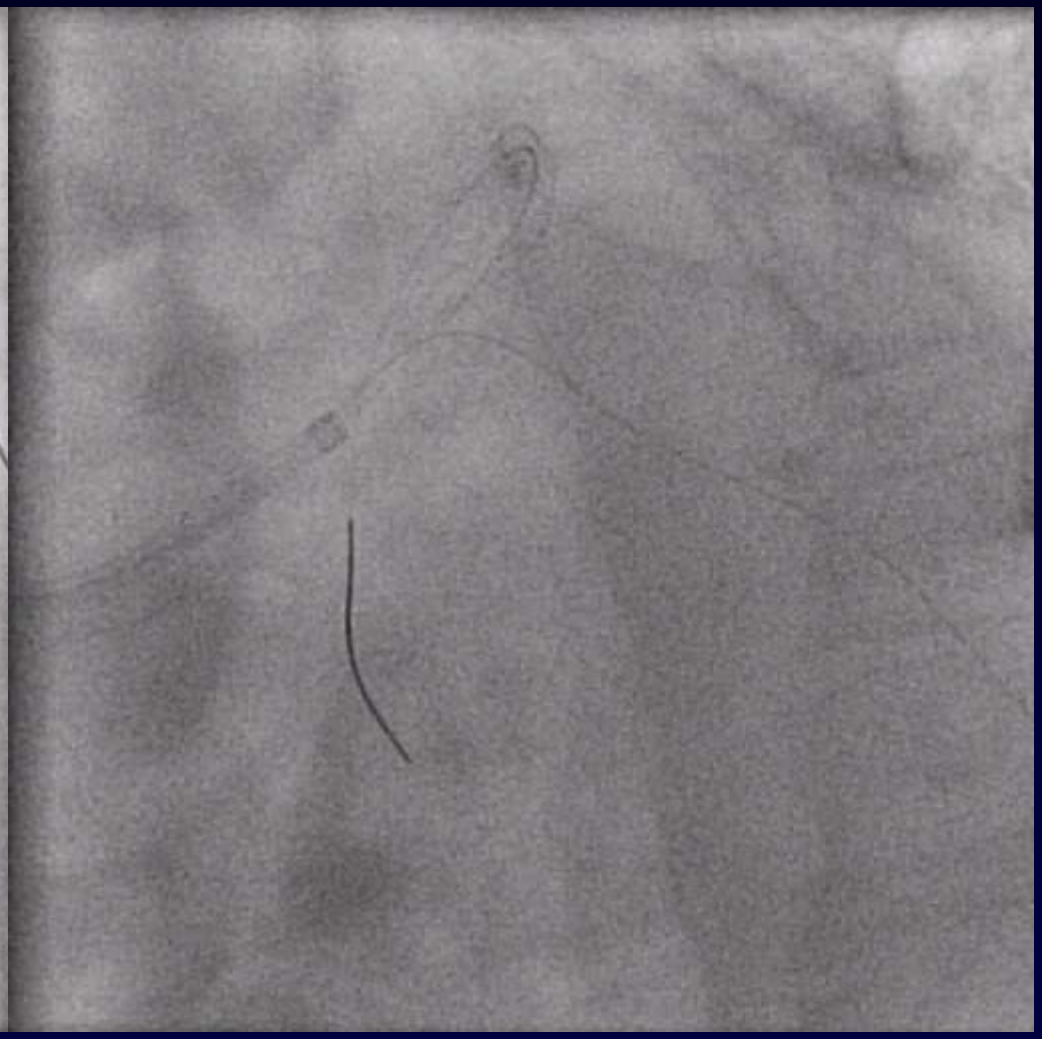
Endeavor R 2.75x18 was deployed at pLCX



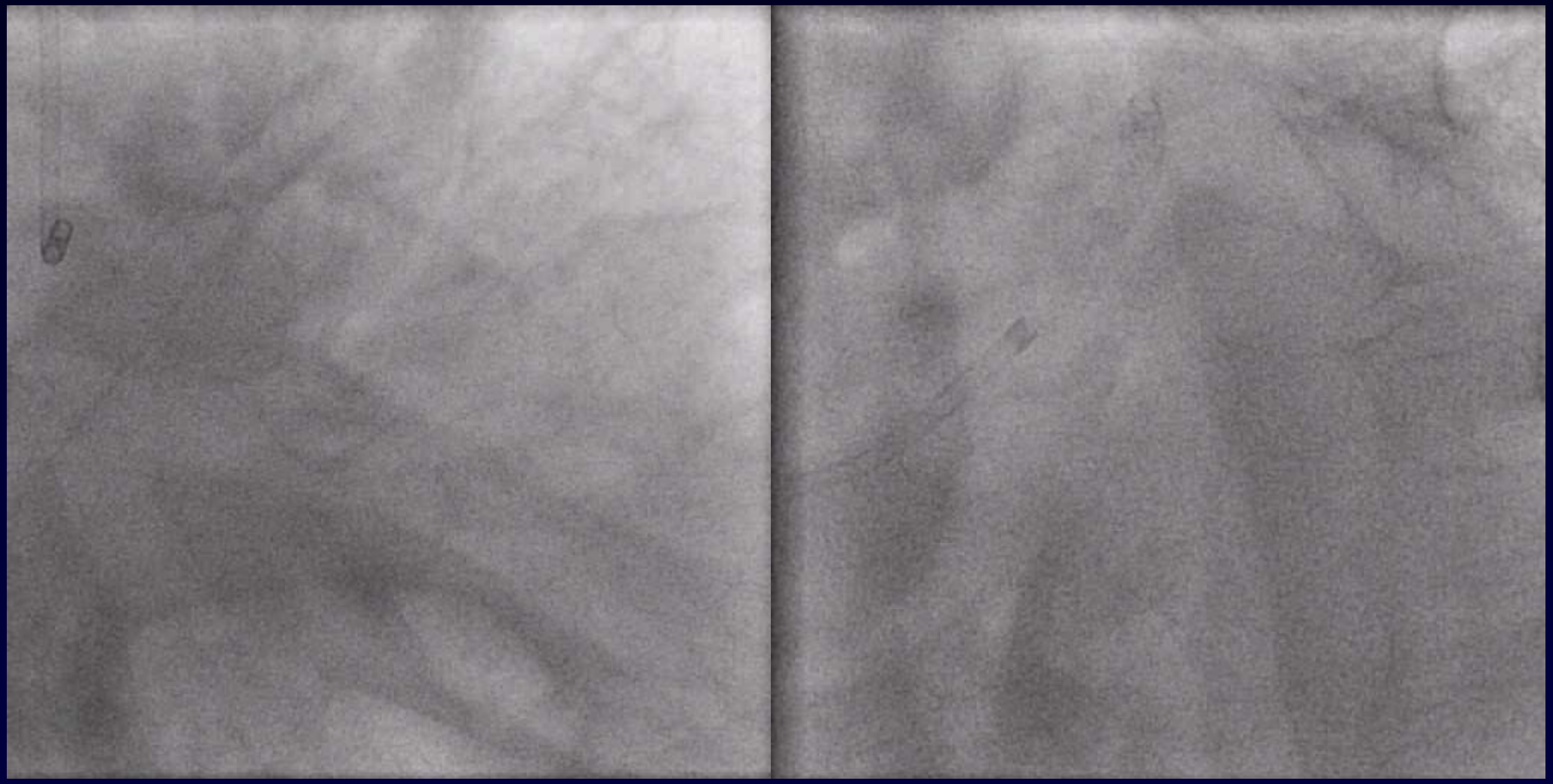
Antegrade angioplasty

Intermedius br. flow was spontaneously recovered after stenting





Final angiogram



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e-Chronic Total Occlusion Club

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Endovascular & Coronary Revascularization in Seoul
September 26(Fri)-27(Sat), 2008

e-CTO Club is?

English Japanese

By definition, CTO is totally occluded lumen without antegrade blood flow (TIMI grade 0) and duration of disease is over 3 months which calculated on the basis of clinical or angiographic data. Percutaneous revascularization of chronic total occlusion (CTO) still remains as a main hurdle, despite of advances in angioplasty technology and operator experiences. Several decades ago, some reports said that chronic total occlusion (CTO) has been considered unsuitable lesion for coronary angioplasty.

However, due to recent technological advances and enormous Japanese operator's efforts, percutaneous transluminal coronary angioplasty (PTCA) has been attempted in a large number of patients with CTO recent years.

***E-CTO club** would like to guide and support you to perform successful CTO intervention with the expertise's help about details of methodology including selection of instruments such as guiding catheter for adequate support, specialized guidewires for penetration and experienced hand skills. And furthermore, new evolving technology and crossing techniques was introduced as supportive informations for our colleagues.*

I hope all the colleagues enjoy the prosperous outcome with CTO lesions via e-CTO club.

Thanks for your participation
Yangsoo Jang, MD, PhD, FACC

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http://www.e-cto.org/

Thank you for your attentions !