HOW TO ACHIEVE OPTIMAL RESULT: PHYSIOLOGY AND IMAGING GUIDED PCI

DIFFUSE TANDEM LESION

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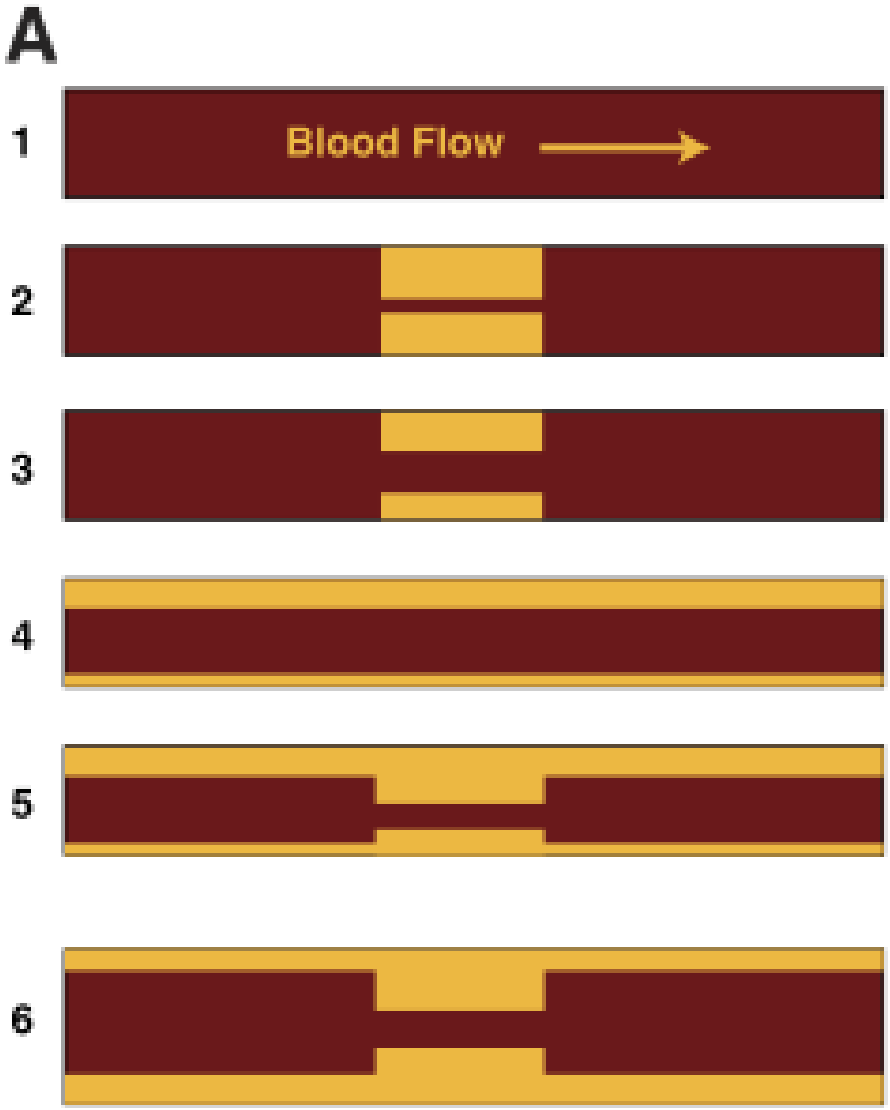
Disclosure Statement of Financial Interest

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

Affiliation/Financial Relationship	Company
• Consulting Fees/Honoraria	• Zeon Medical Inc, Abott Vascular Phillips volcano, Boston Scientific, Kaneka Medical Inc,

Coronary Function Versus Anatomy With Diffuse Coronary Artery Disease and Remodeling



No stenosis CFR = 4.0

87% stenosis CFR = 1.0

63% stenosis CFR = 3.4

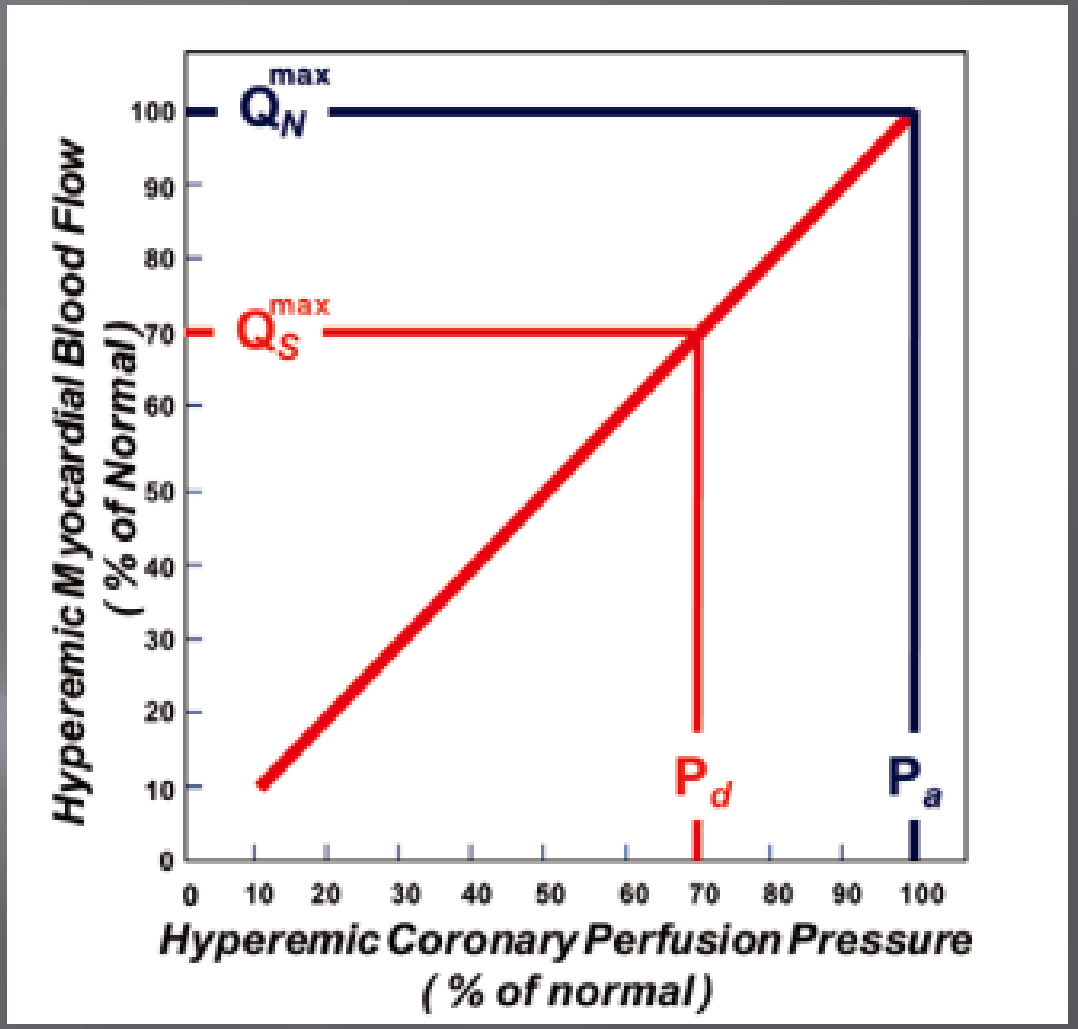
Diffuse no stenosis
IVUS 38% CFR = 1.4

Diffuse + 60% Artgm
IVUS 75% CFR = 1.0

Diffuse + 62% Artgm
IVUS 75% & adaptive
remodeling CFR = 3.5

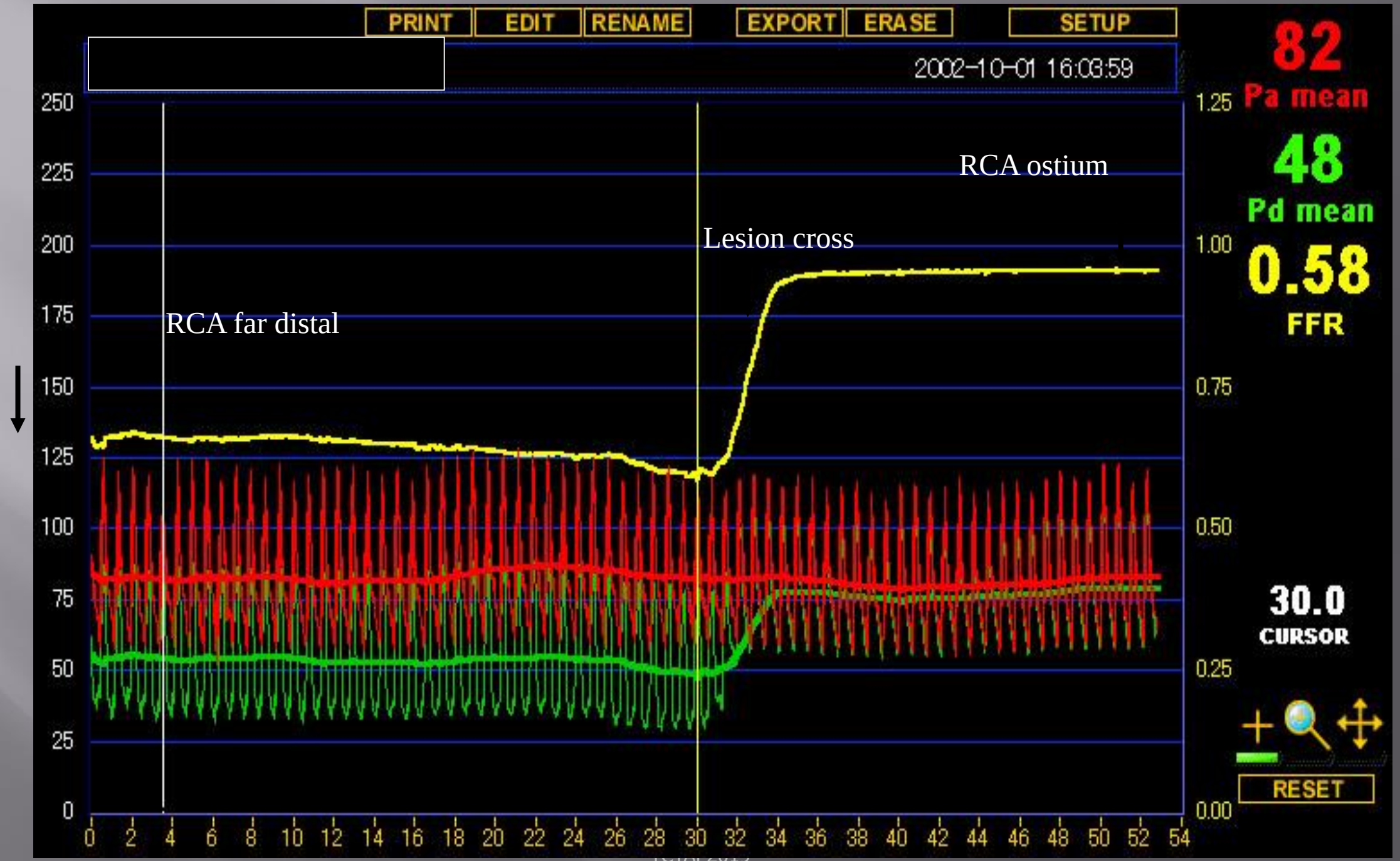
Gould, K. L. J Am Coll Cardiol Img 2009;2:1009-1023

What is FFR?

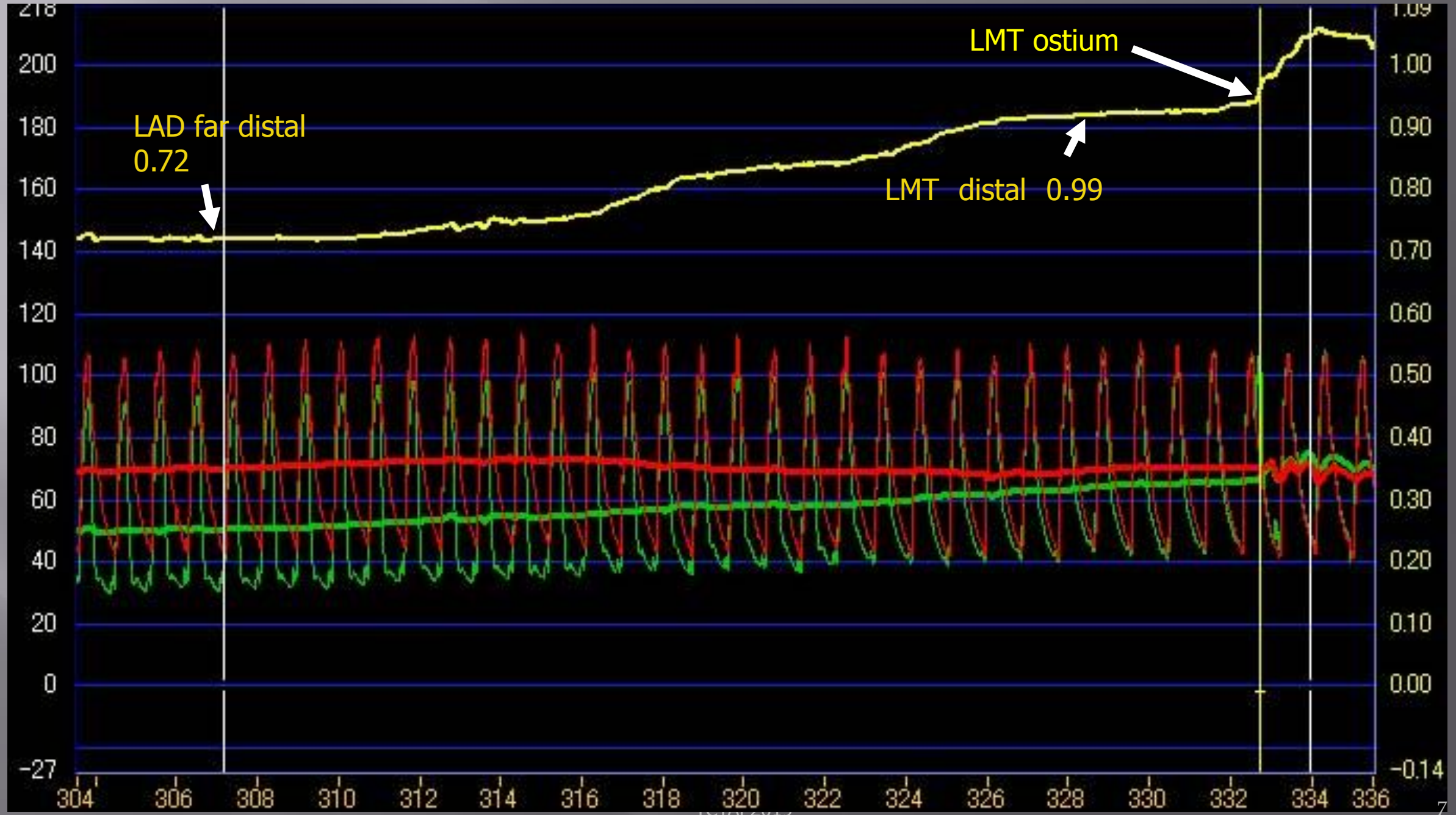


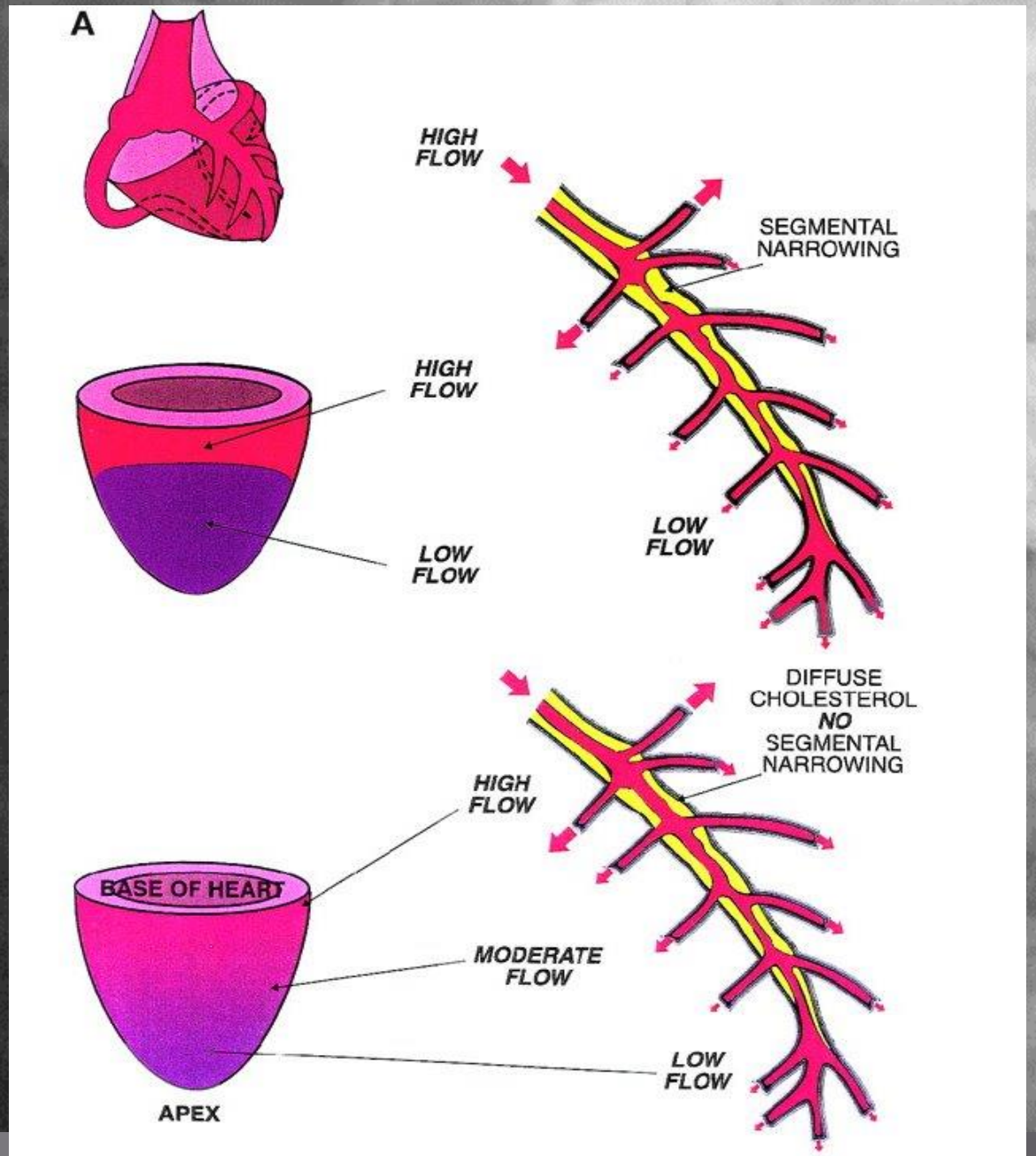
$$\mathbf{FFR} = \frac{Distal\ Coronary\ Pressure\ (Pd)}{Aortic\ Pressure\ (Pa)}$$

During maximal hyperemia


PRINT
EDIT
RENAME
EXPORT
ERASE
SETUP
2002-10-01 16:03:59
82
Pa mean
48
Pd mean
0.58
FFR
30.0
CURSOR
RESET
RCA ostium
Lesion cross
RCA far distal
250
225
200
175
150
125
100
75
50
25
0
1.25
1.00
0.75
0.50
0.25
0.00
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48 50 52 54


UPDATE
EDIT
PRINT
PLAY
EXPORT
RENAME
DELETE
SETUP
B-3
2011-10-22 08:44:15
(100)
Pa mean
(60)
Pd mean
0.60
FFR
179.76
CURSOR
AUTOSCALE


LMT ostium
LAD far distal
0.72
LMT distal 0.99
200
180
160
140
120
100
80
60
40
20
0
-27
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
-0.14
304
306
308
310
312
314
316
318
320
322
324
326
328
330
332
334
336



Gould, K. L. J Am Coll Cardiol Img 2009;2:1009-1023

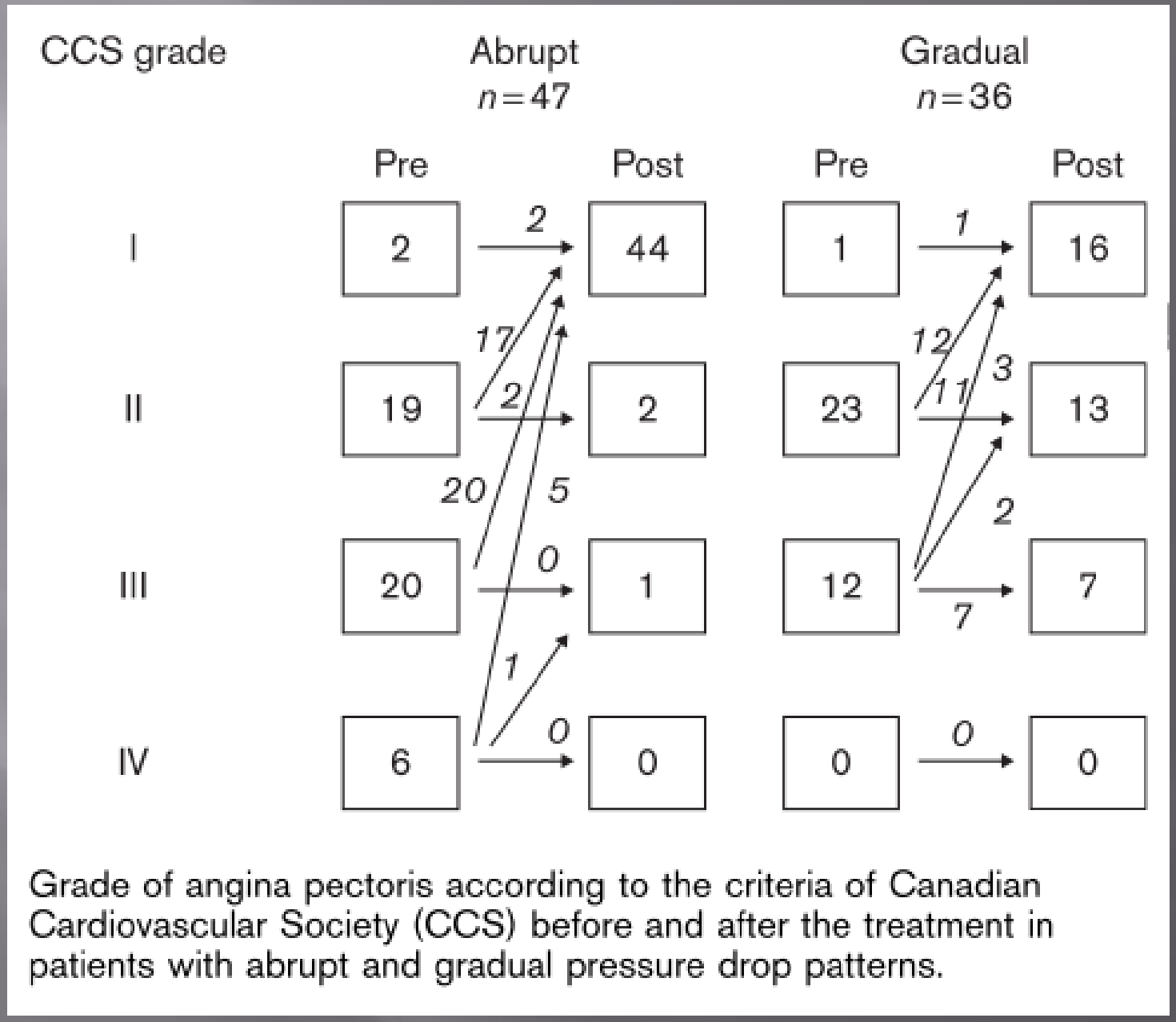
Table 1 Clinical, angiographic, and coronary pressure characteristics of patients with abrupt and gradual pressure drop patterns

	Abrupt	Gradual	*P* value
n	47	36	
Age (years)	66.3 ± 10.2	67.9 ± 7.4	NA
Sex (male : female)	32 : 15	28 : 8	NA
AP : MI	30 : 17	22 : 14	NA
Coronary risk factor, *n* (%)			
Hypertension	40 (85)	30 (83)	NA
Hyperlipidemia	26 (55)	23 (64)	NA
Diabetes	32 (68)	23 (64)	NA
Obesity	17 (36)	14 (39)	NA
Smoking	35 (74)	23 (64)	NA
Angiographic findings			
Proximal RVD (mm)	2.47 ± 0.41	2.58 ± 0.37	NA
Distal RVD (mm)	2.05 ± 0.37	2.12 ± 0.28	NA
MLD (mm)	1.57 ± 0.27	1.64 ± 0.30	NA
Site of pressure drop			
One point 6 : 7	28 : 12		
Two points (6 : 7 : 6&7)	2 : 2 : 3		
FFR	0.65 ± 0.12 (0.38–0.90)	0.72 ± 0.08 (0.56–0.86)	<0.01

6 and 7 is according to 'A reporting system on patients evaluated for coronary artery disease' reported by Ad Hoc Committee for Grading of Coronary Artery Disease, Council on Cardiovascular Surgery, American Heart Association (*Circulation* 1975; 51:5–40).

AP, angina pectoris; FFR, fractional flow reserve; MI, prior myocardial infarction; MLD, minimal lumen diameter; NA, not applicable; RVD, reference vessel diameter.

Iwasaki K, et al. Coron Artery Dis. 2011 Mar;22(2):81-6.



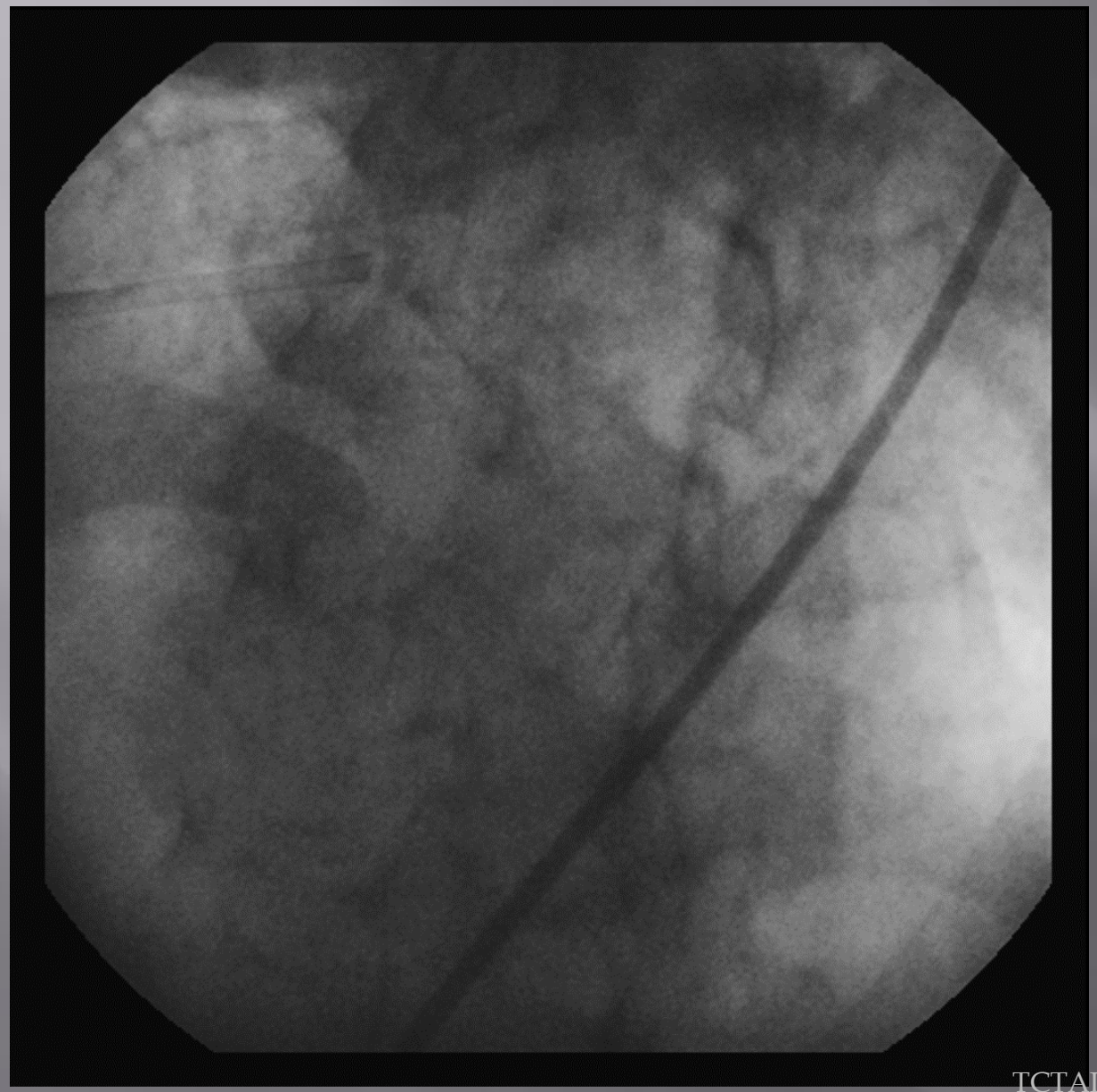
Grade of angina pectoris according to the criteria of Canadian Cardiovascular Society (CCS) before and after the treatment in patients with abrupt and gradual pressure drop patterns.

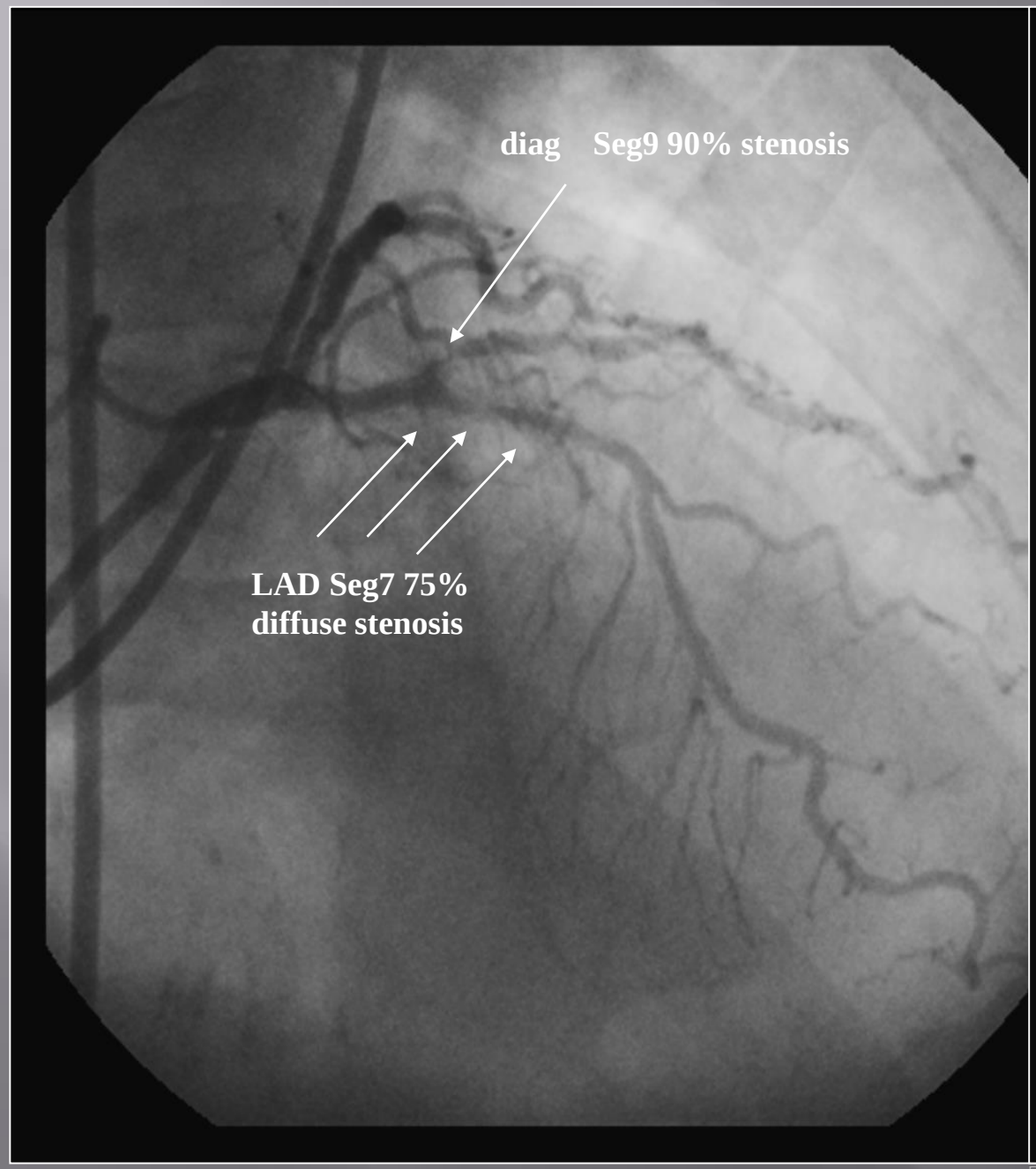
Iwasaki K, et al. Coron Artery Dis. 2011 Mar;22(2):81-6.

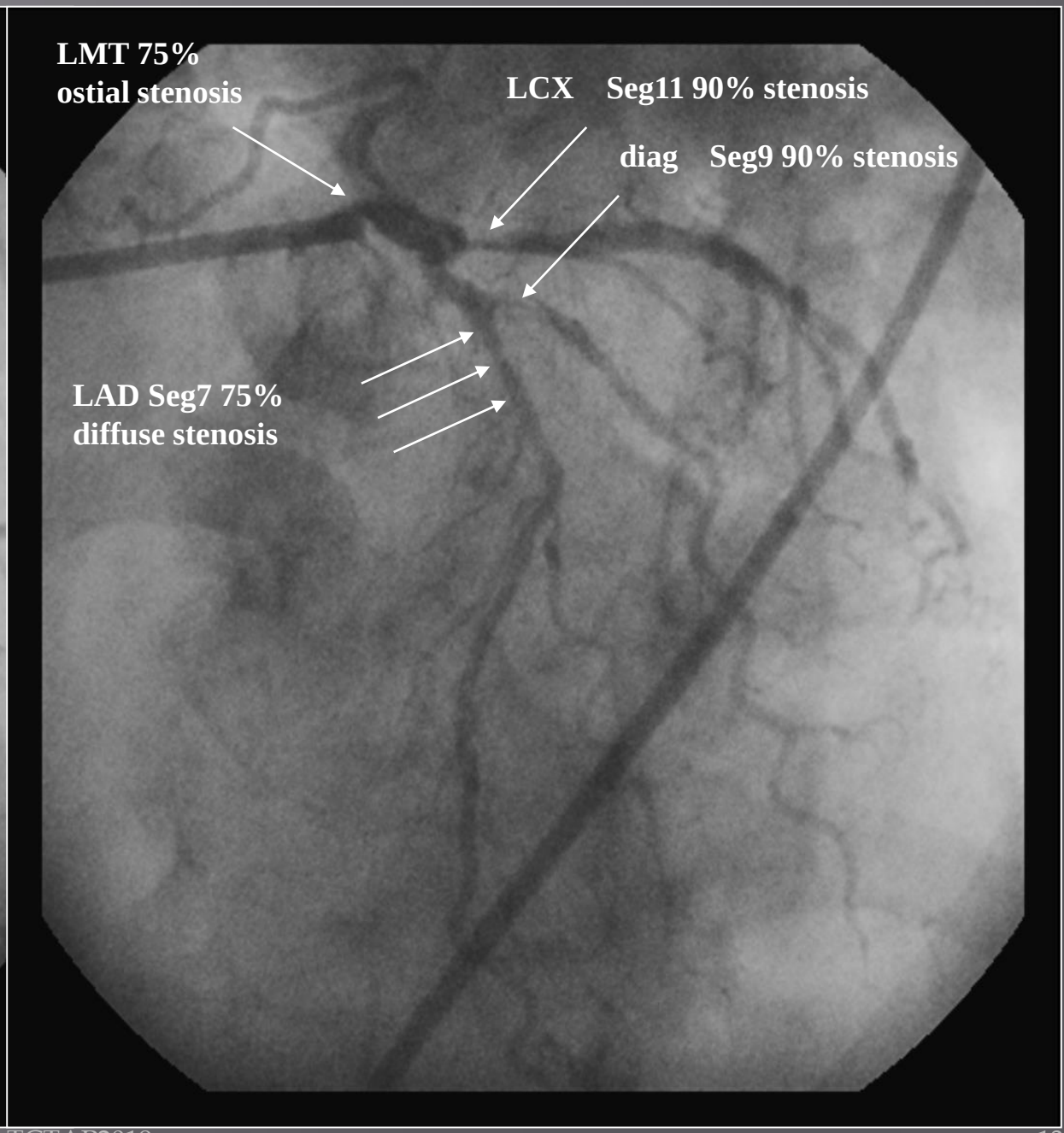
Case Y.M 79y.o M.

- OMI (inf)
- Risk factor : Hypertension, DM
- Angiography : Severe 2VD
- LMT 50%
  LAD seg7 diffuse calcified desase 75%
  Diagonal branch 75%
  LCX seg11 ostium 75-90% stenosis
- LVEF 50% diffuse mild hypokinesis
- CKD(+) Cr 1.6mg/dl eGFR 30.9ml/min/1.73m2

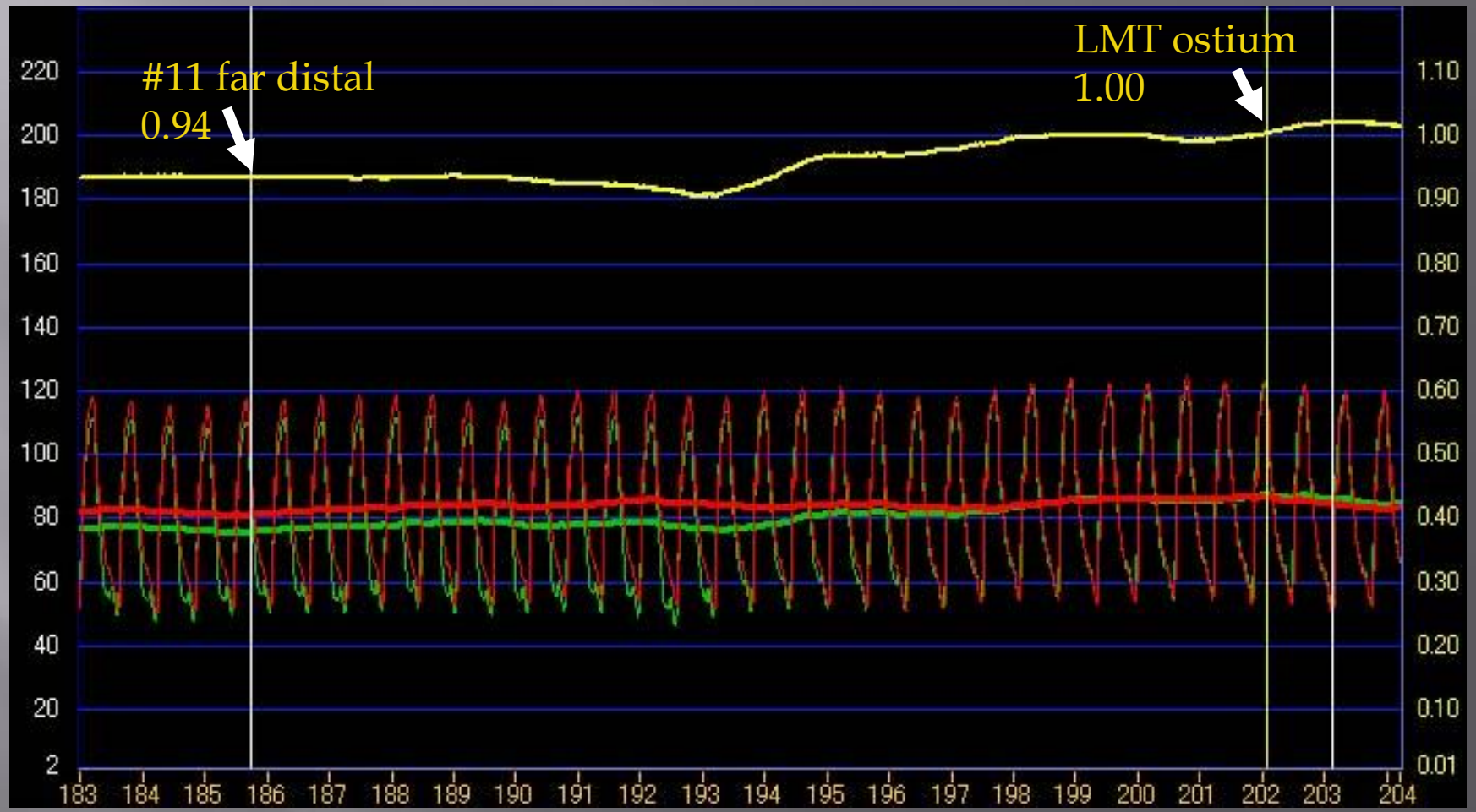
Coronary angiography




diag Seg9 90% stenosis
LAD Seg7 75%
diffuse stenosis

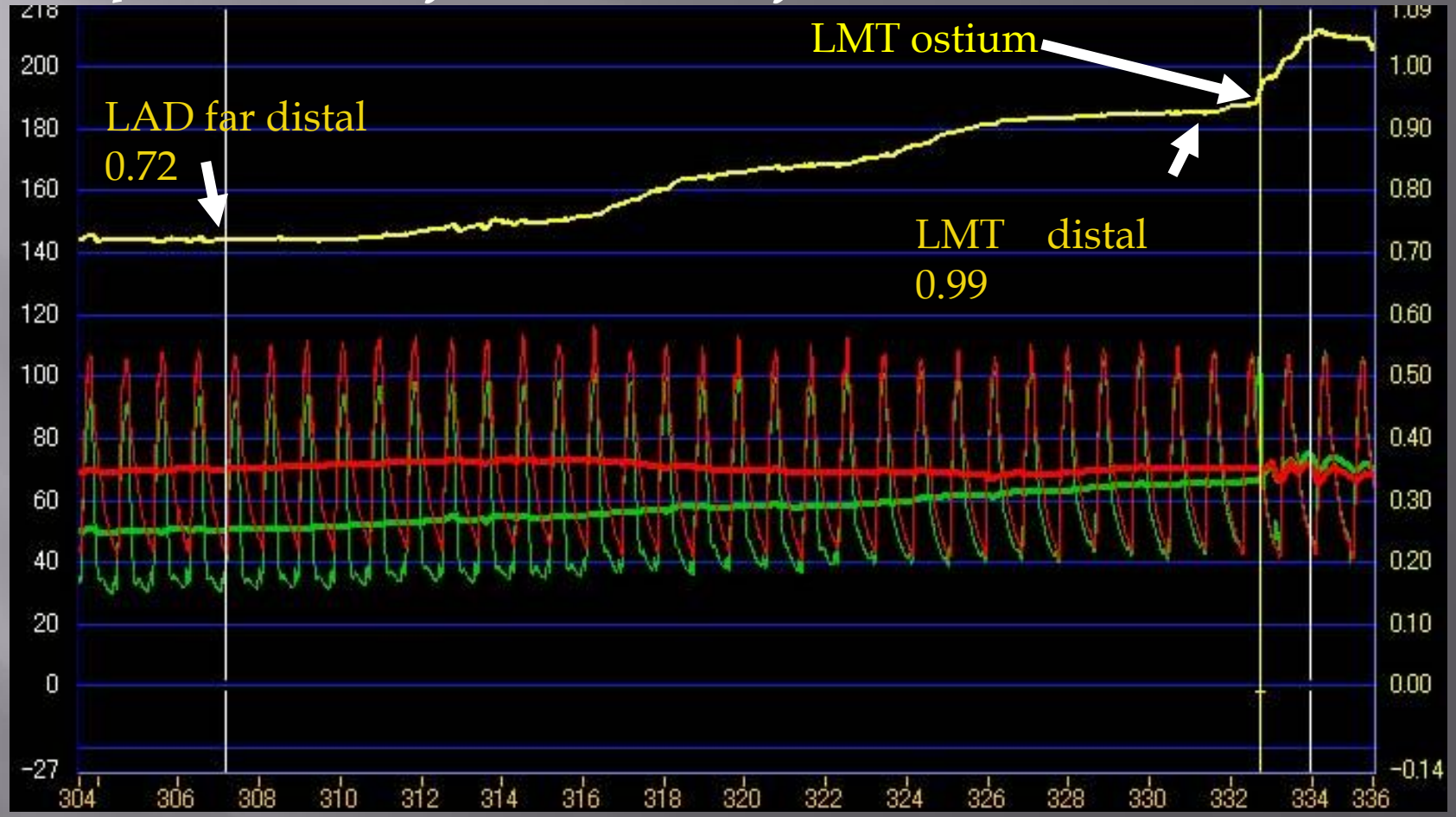

LMT 75%
ostial stenosis
LCX Seg11 90% stenosis
diag Seg9 90% stenosis
LAD Seg7 75%
diffuse stenosis

Pressure Wire
pull back from LCX far distal to LMT



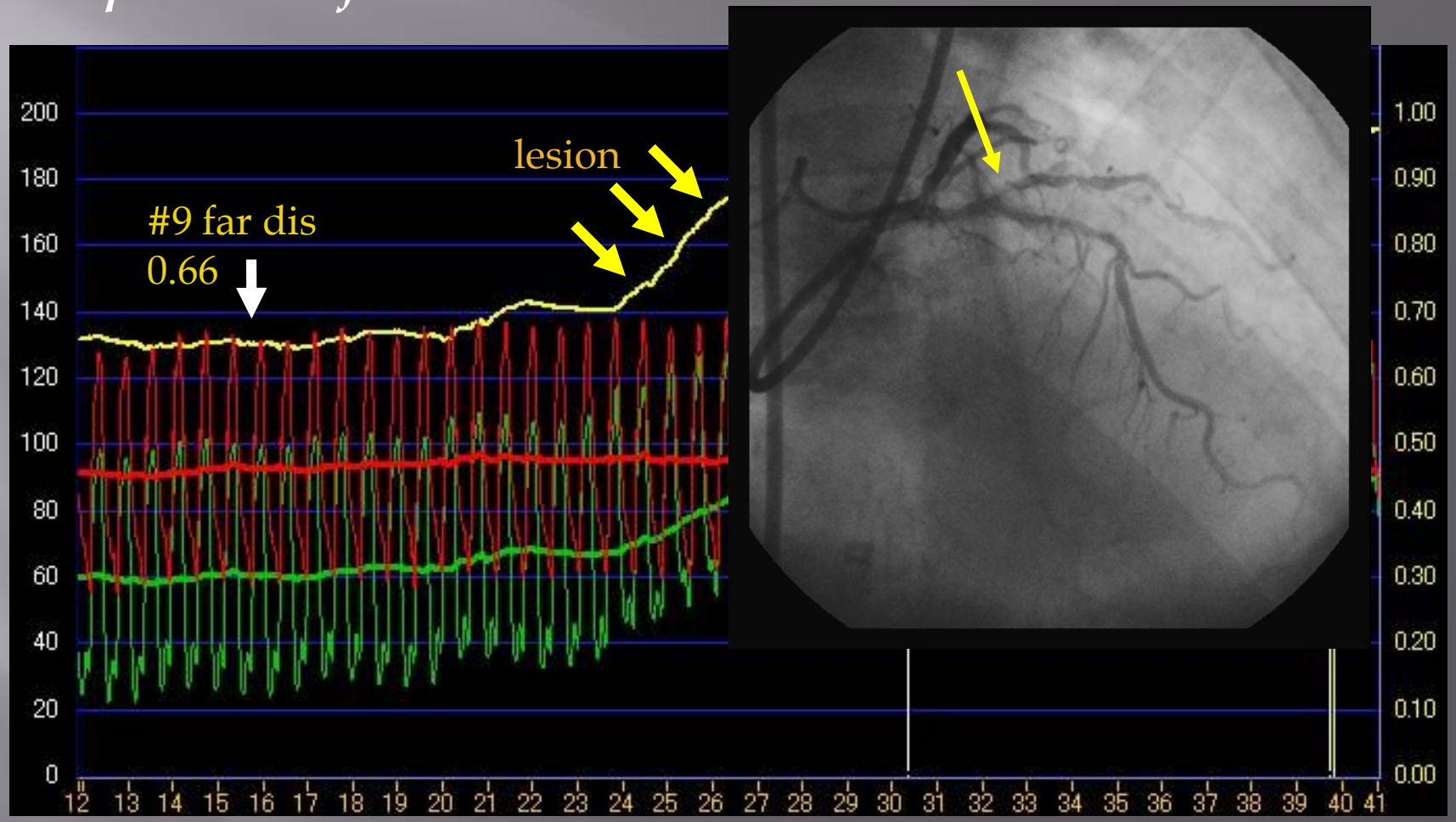
	Pa	Pd(w)	FFR
#11 far distal	82	76	0.94
#11 prox	85	85	1.00

Pressure Wire
pull back from LAD far distal to LMT



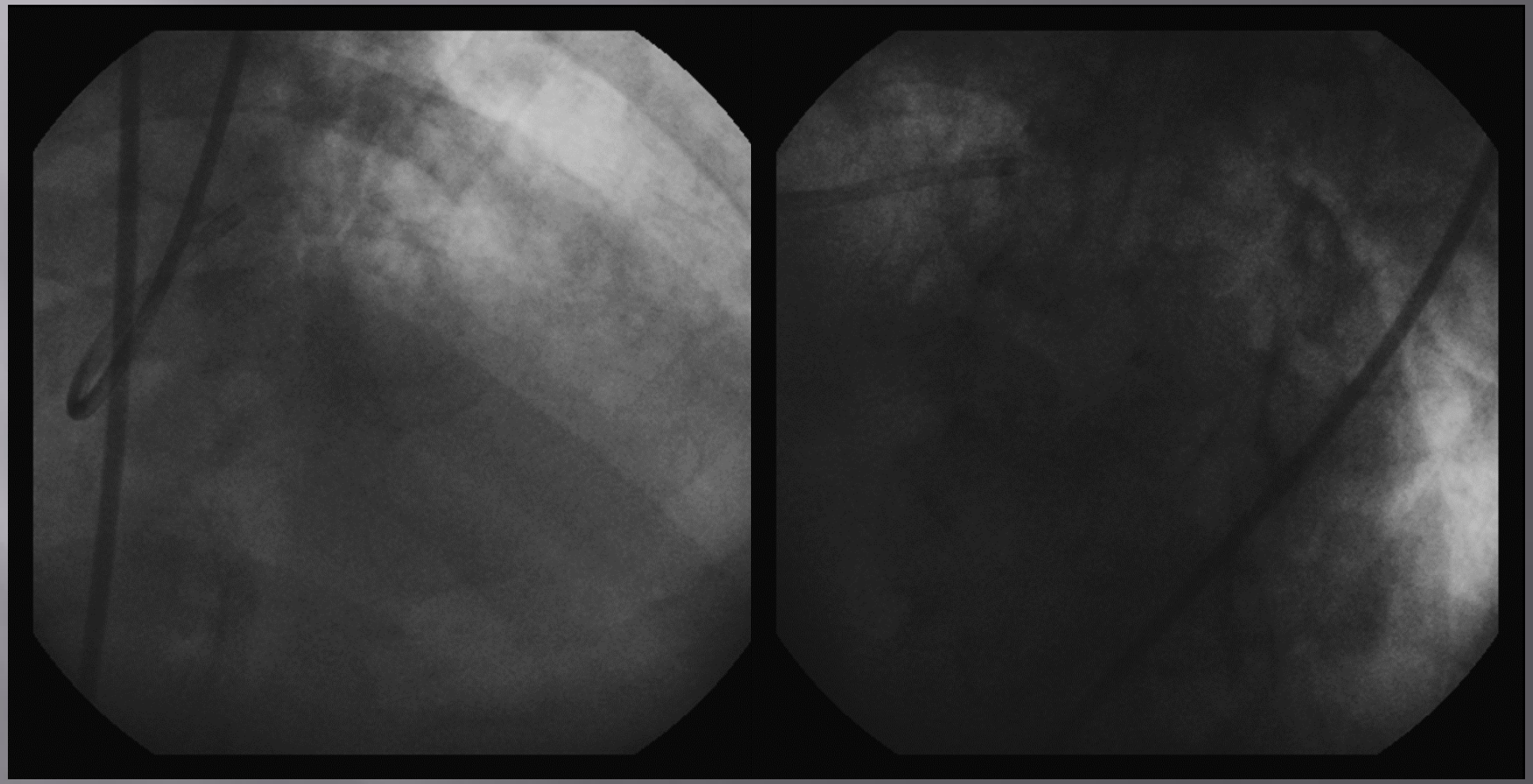
	Pa	Pd(w)	FFR
LAD far distal	70	50	0.72
LMT distal	68	67	0.99

Pressure Wire
pull back from #9 distal to LMT

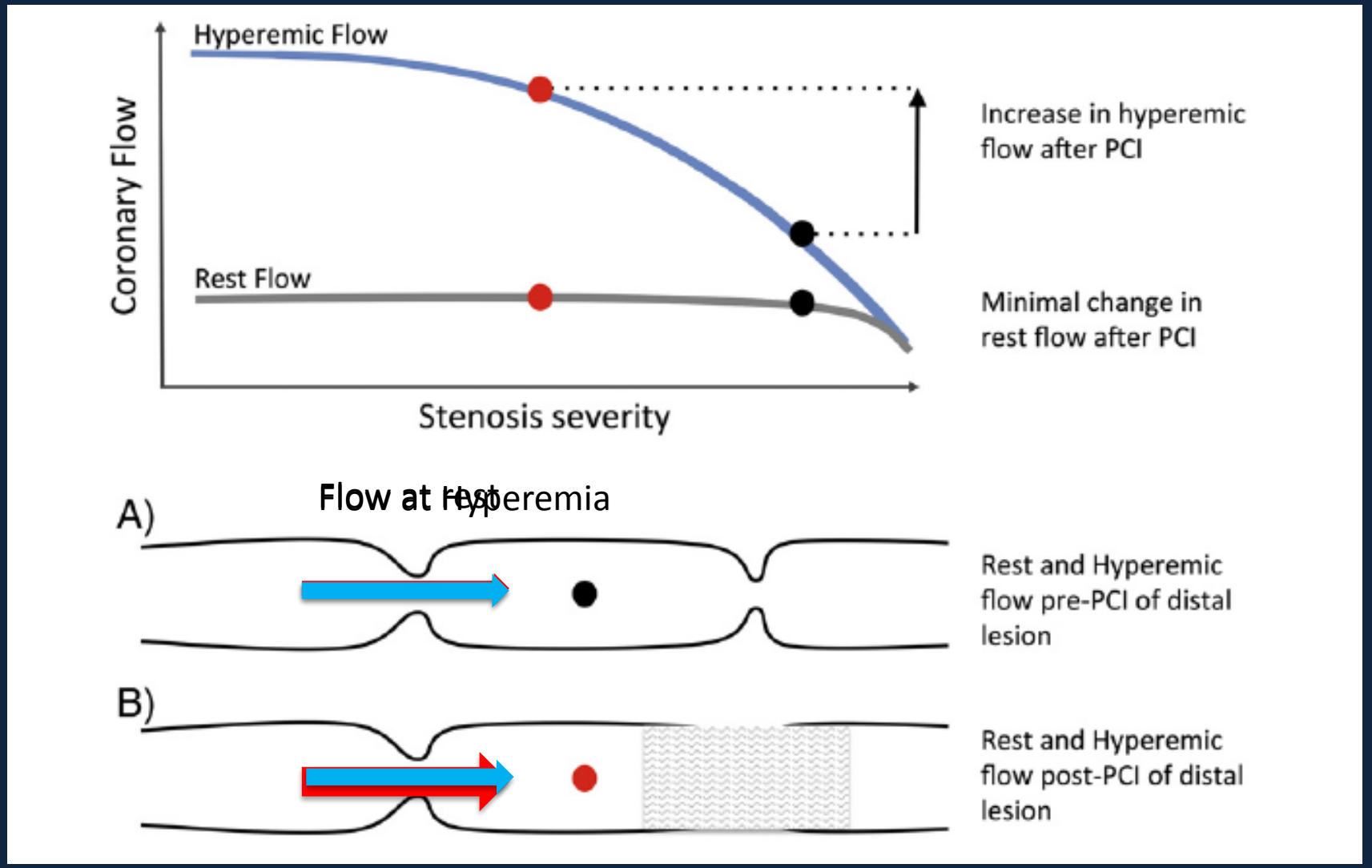


	Pa	Pd(w)	FFR
#9 far distal	92	61	0.66
#6 prox	97	89	0.91
LMT	93	90	0.97

PTCA to #9　(rotablator 1.75mm+ 2.5mm POBA)

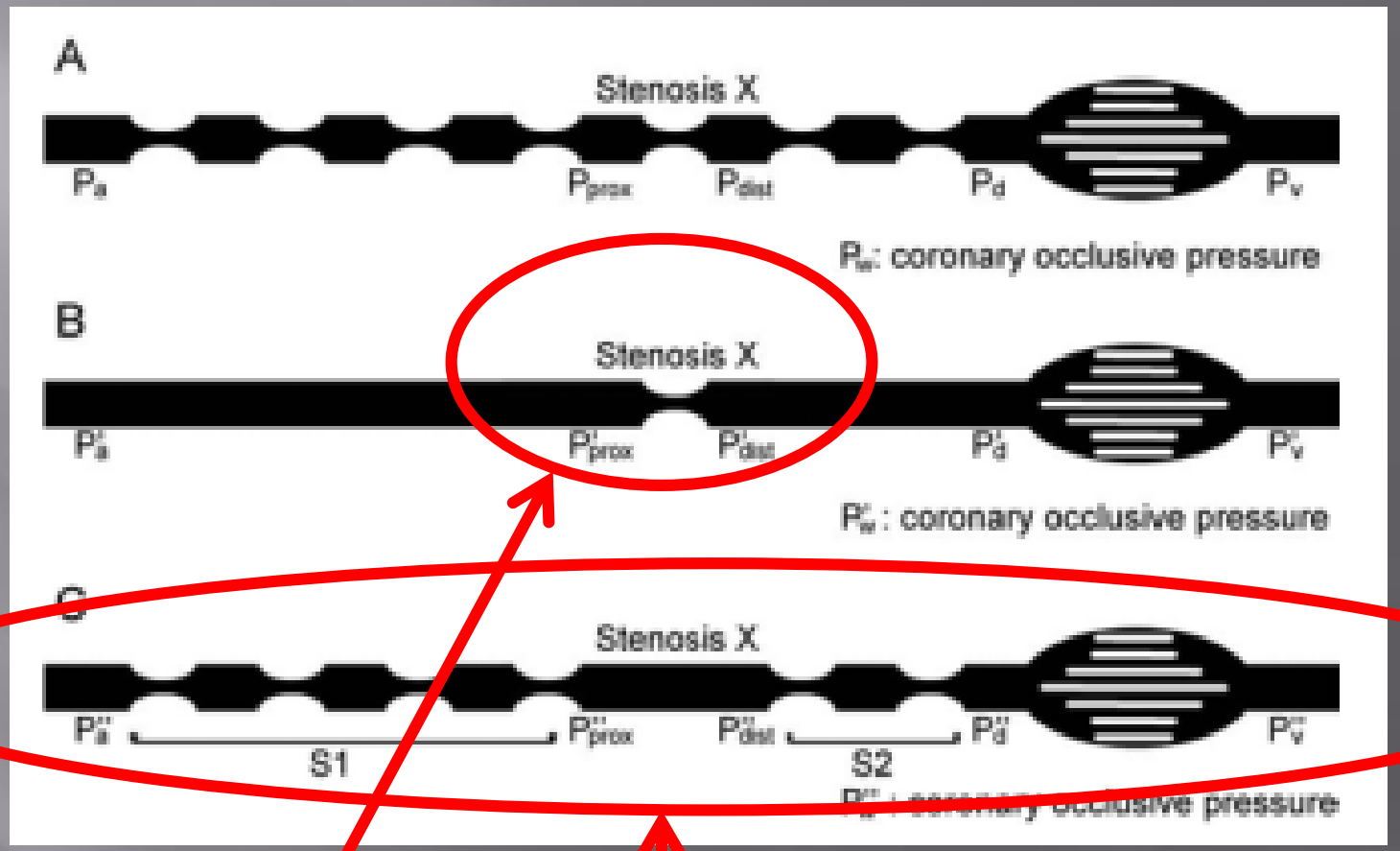


Contrast volume used in this case was only 40ml.



Nijjer SS et al. Cardiovasc Revasc Med 2015;16:167-71.

Model of multiple sequencial stenosis

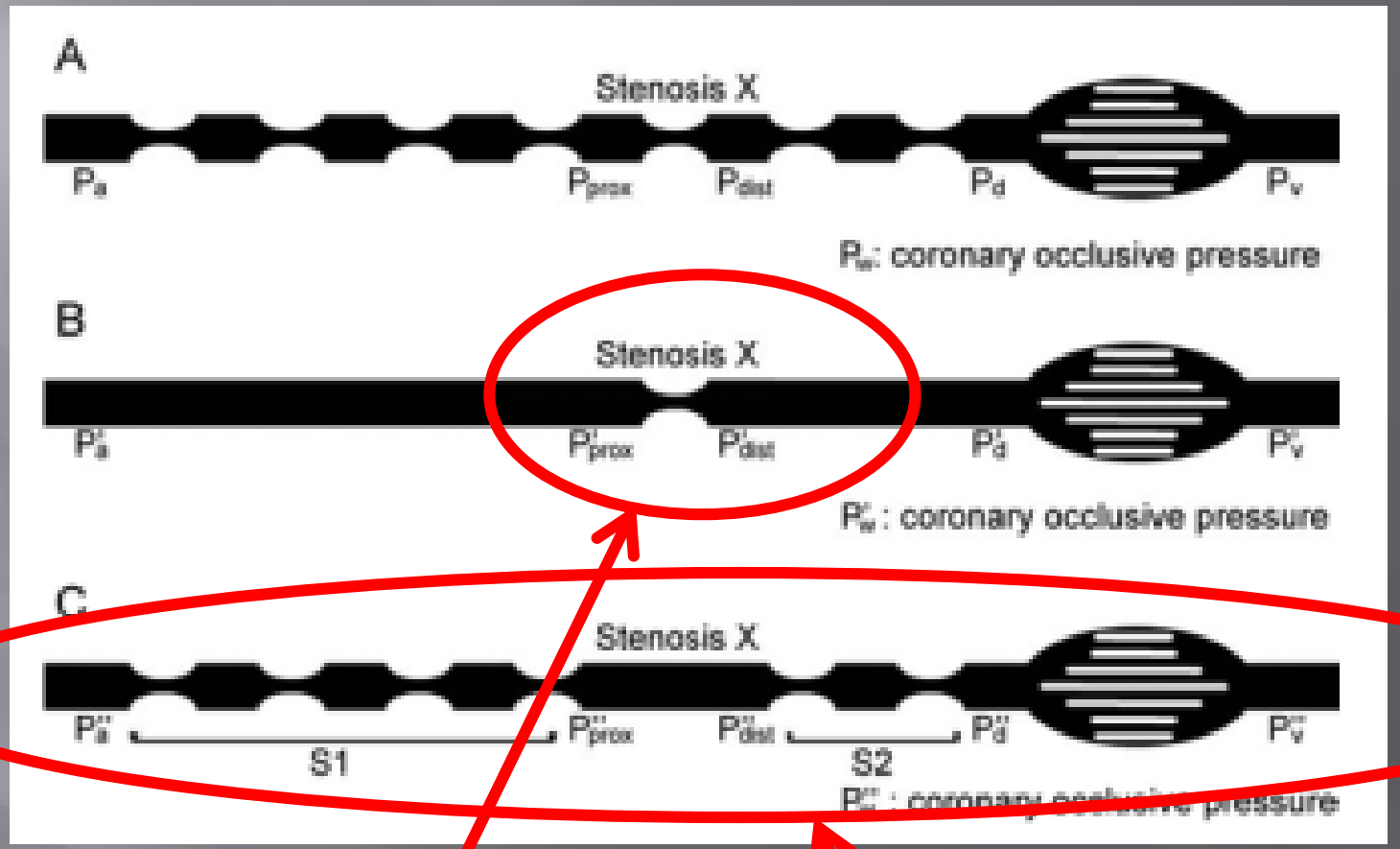


$$FFR(X-)_{pred} = \frac{P_d - P_w}{P_a - P_{prox} + P_{dist} - P_w} + \frac{P_w(P_a - P_{prox} + P_{dist} - P_d)}{P_a(P_a - P_{prox} + P_{dist} - P_w)}$$

$$= \frac{P_d - P_w}{P_a - \Delta P - P_w} + \frac{P_w(P_a - \Delta P - P_d)}{P_a(P_a - \Delta P - P_w)} \quad (B)$$

2-9..

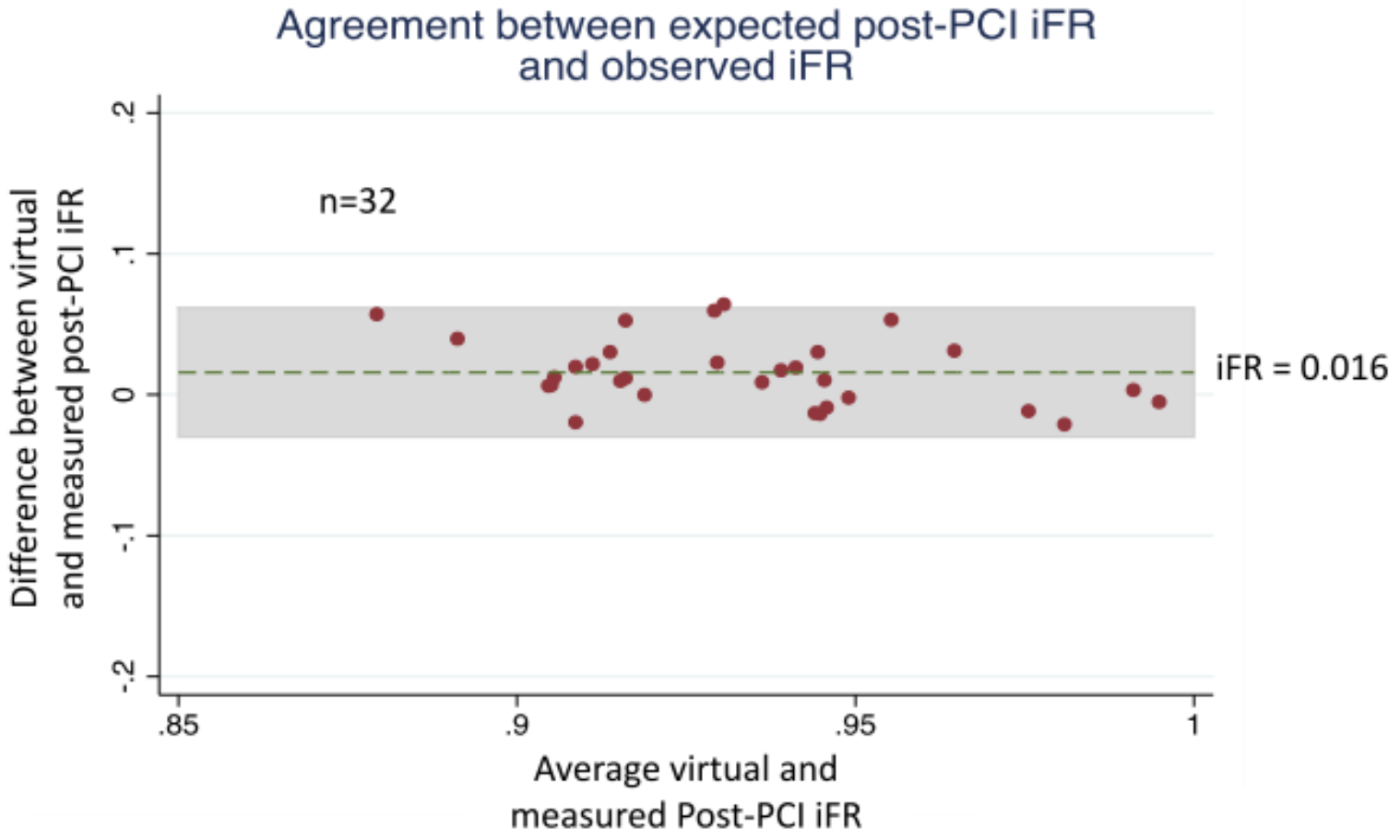
In Vitro Assessment of Mathematically-Derived FFR in Coronary Lesions With More Than Two Sequential Stenoses



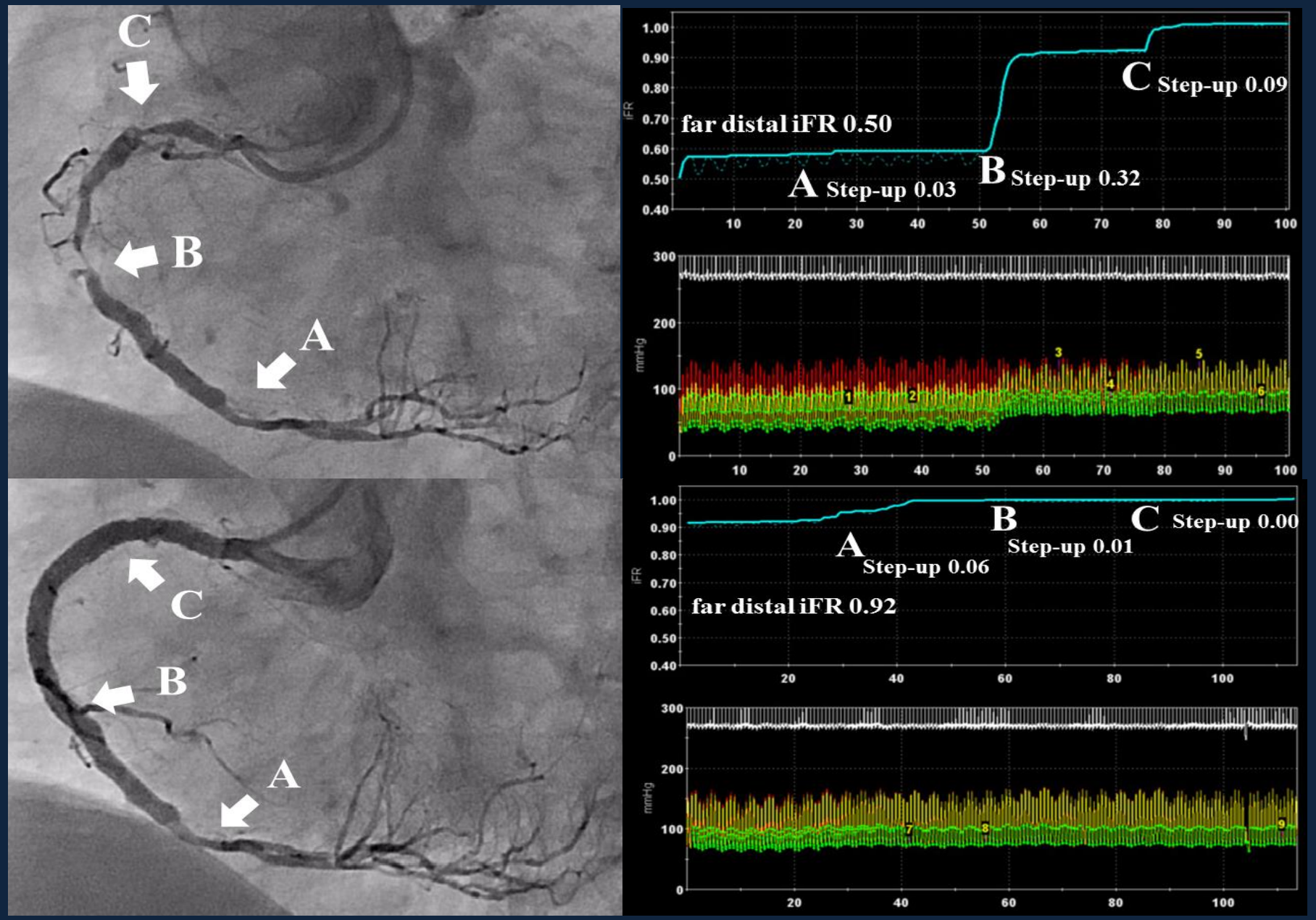
$$iFR(X\text{-}) = iFRpre + \Delta iFR(X)$$

$$iFR\ (X)Pred = 1 - \Delta iFR(X)$$

No systematic underestimation of lesion severity with iFR pullback

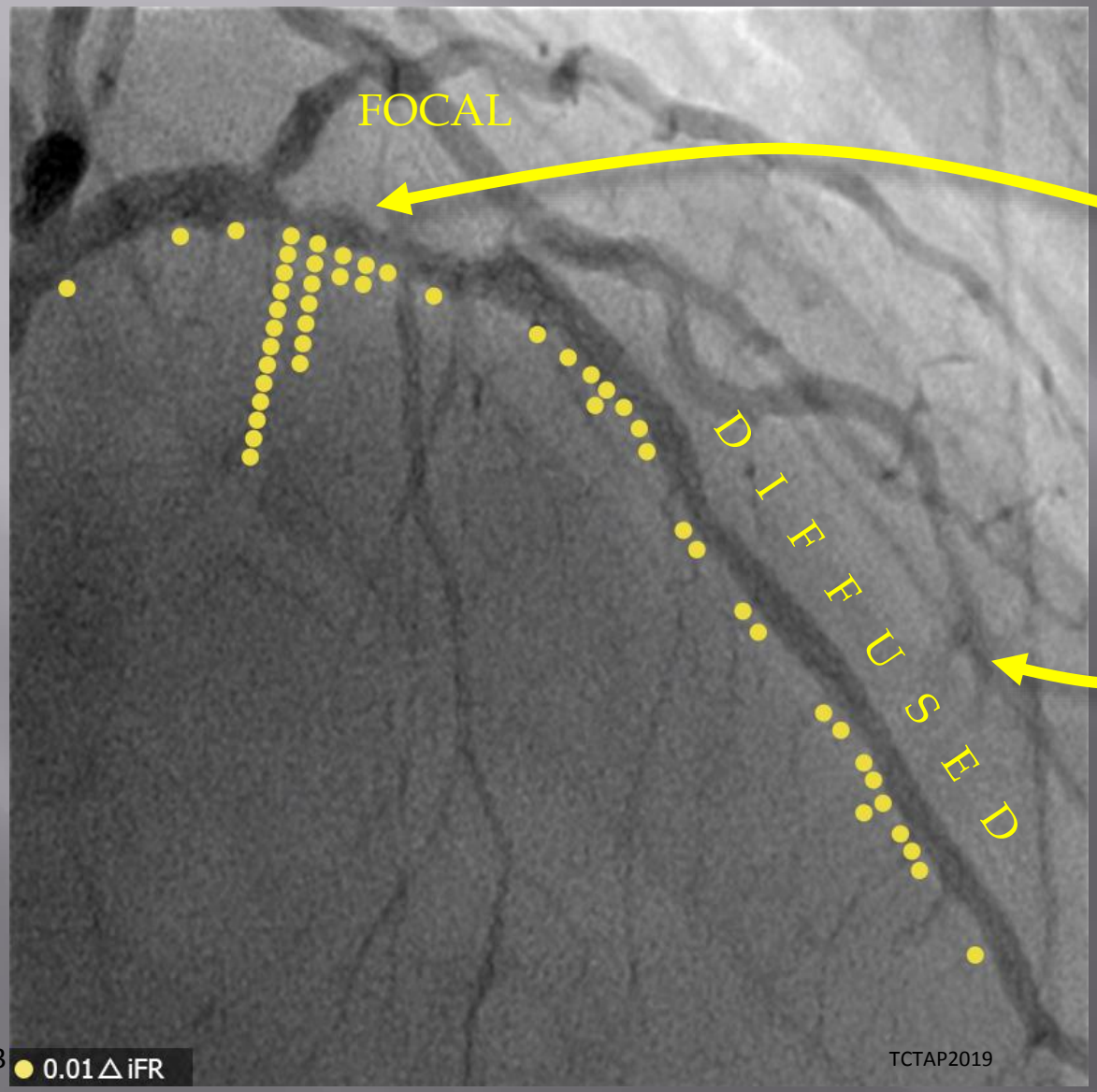


Nijjer SS et al. JACC Cardiol Interv. 2015;8:E001765.



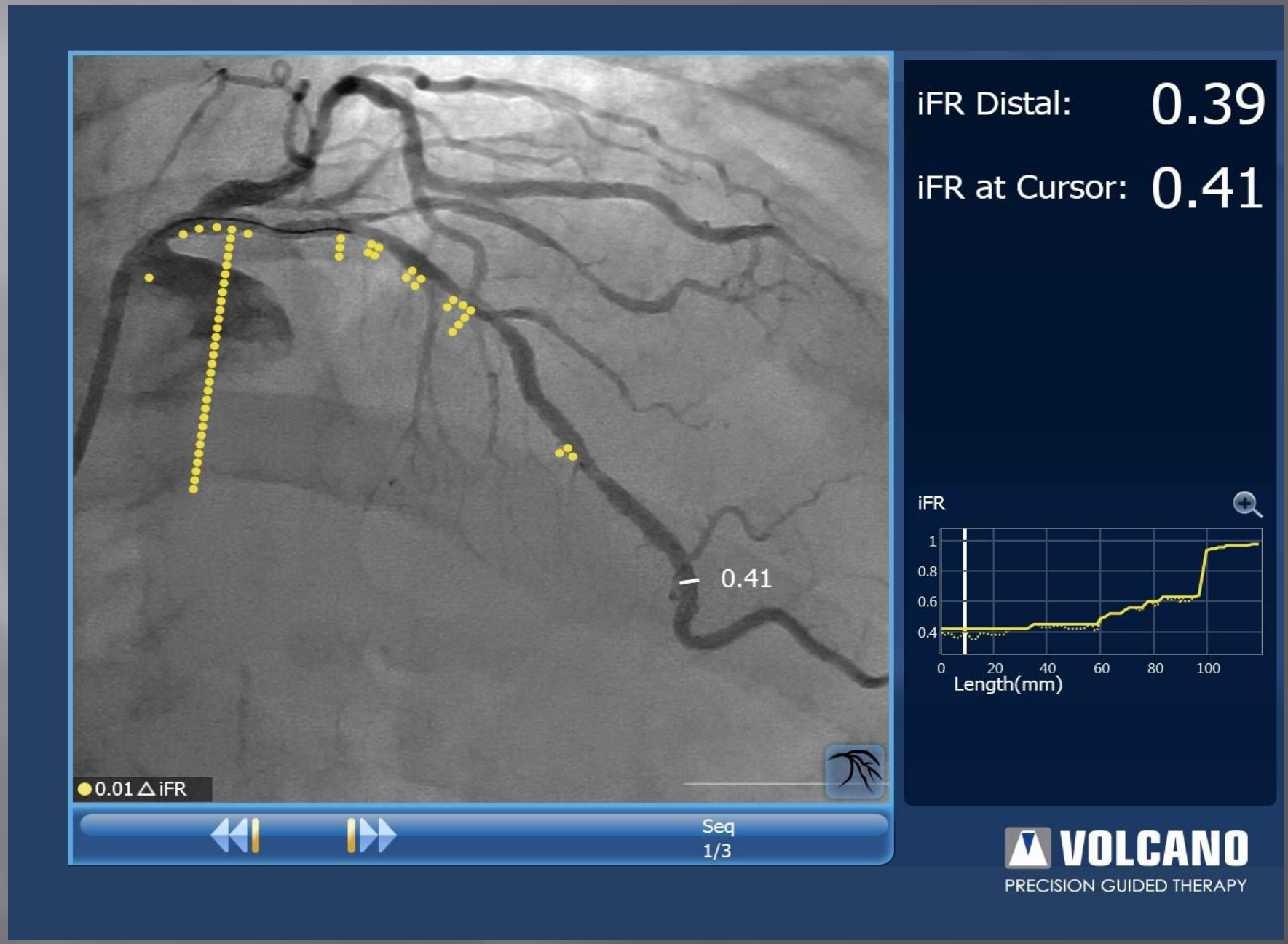
Matsuo H, Kawase Y. Cardiovasc Interv Ther. 2016 Jul;31(3):183-95.

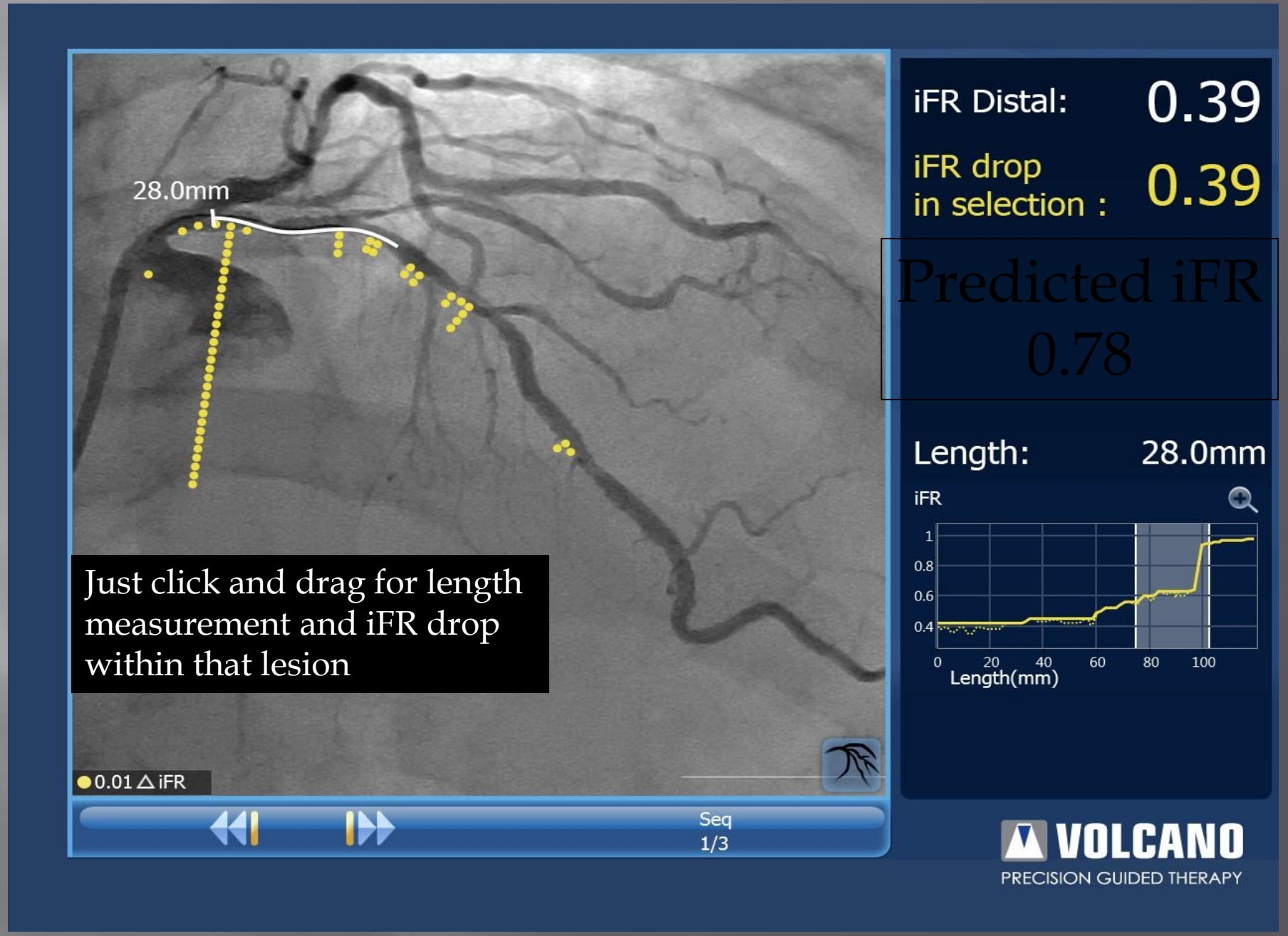
iFR pullback mapping to identify focal and diffuse disease



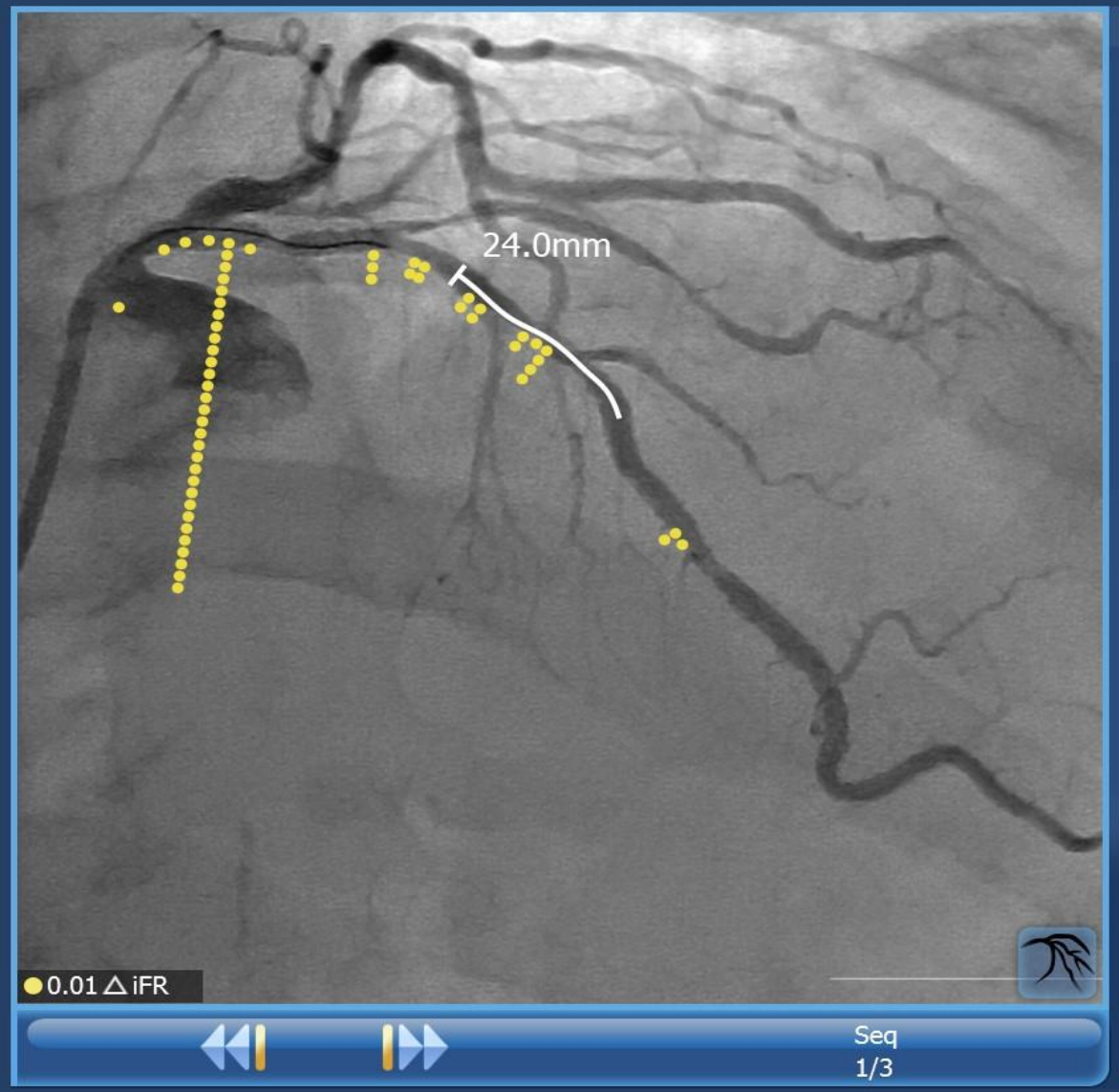
FOCAL
(high pressure drop intensity)

DIFFUSED
(low pressure drop intensity)


iFR Distal: 0.39
iFR at Cursor: 0.41
0.41
0.01 △ iFR
Seq
1/3
iFR
1
0.8
0.6
0.4
0
20
40
60
80
100
Length(mm)
VOLCANO
PRECISION GUIDED THERAPY


28.0mm
Just click and drag for length measurement and iFR drop within that lesion
0.01 △ iFR
Seq
1/3
iFR Distal: 0.39
iFR drop in selection : 0.39
Predicted iFR
0.78
Length: 28.0mm
iFR
1
0.8
0.6
0.4
0
20
40
60
80
100
Length(mm)
VOLCANO
PRECISION GUIDED THERAPY

ANGIO–PHYSIOLOGY COREGISTRATION

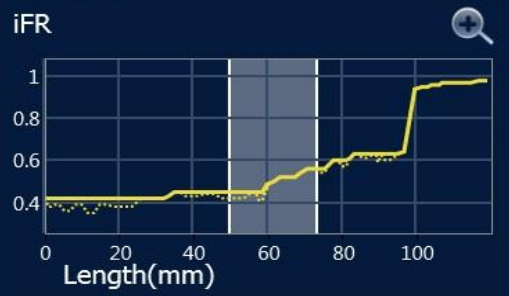


iFR Distal: 0.39

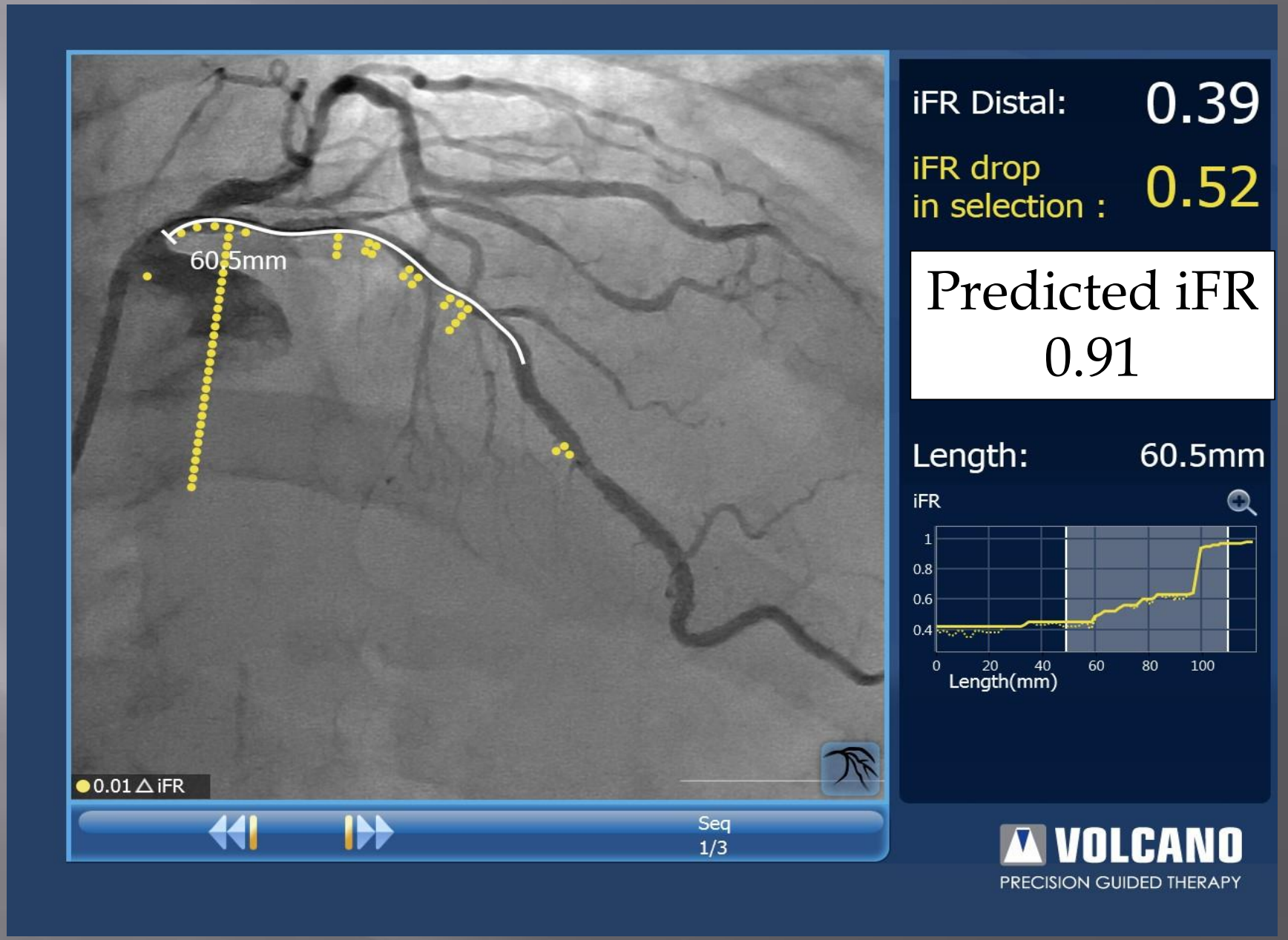
iFR drop in selection : 0.11

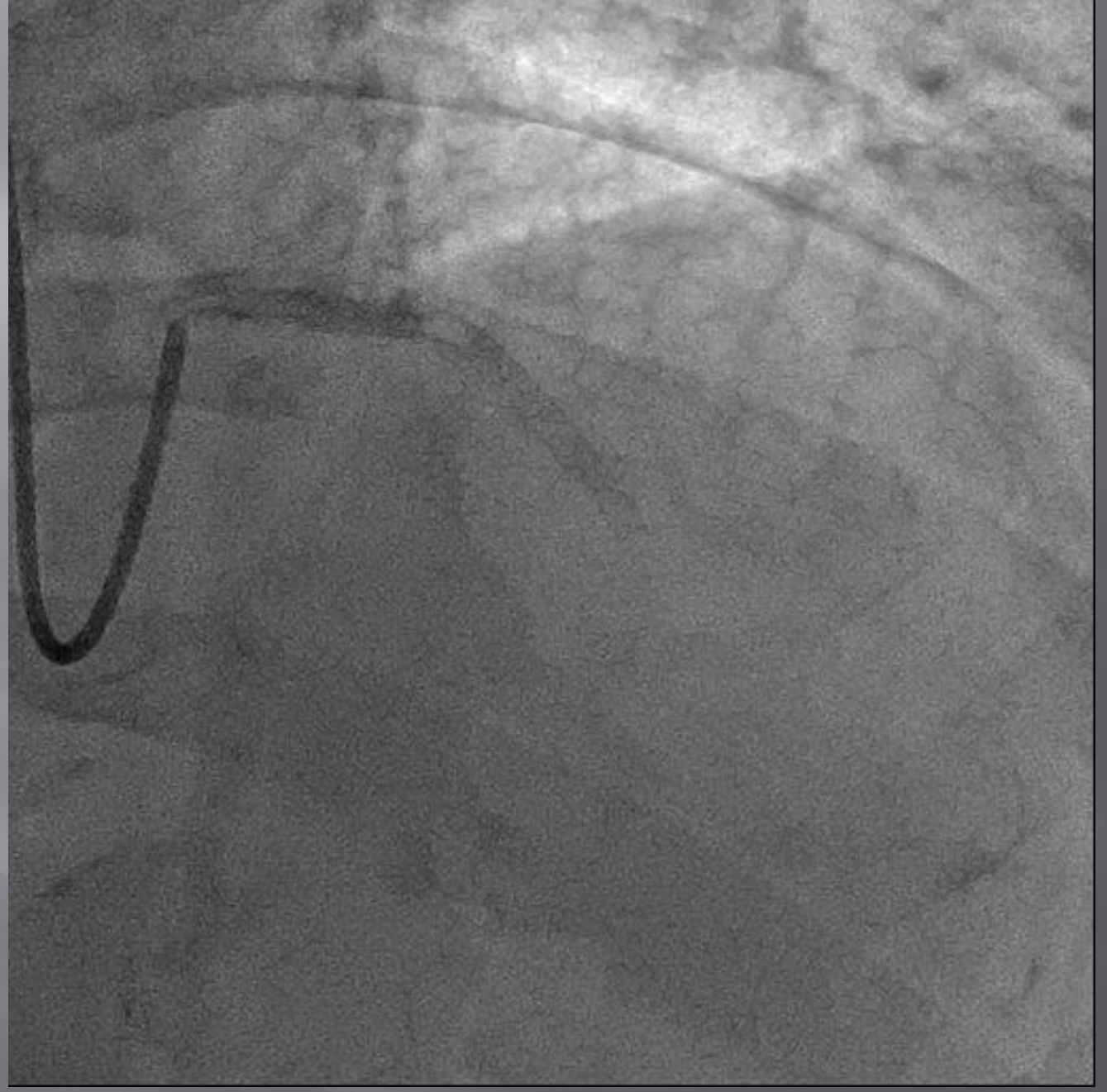
Predicted iFR 0.50

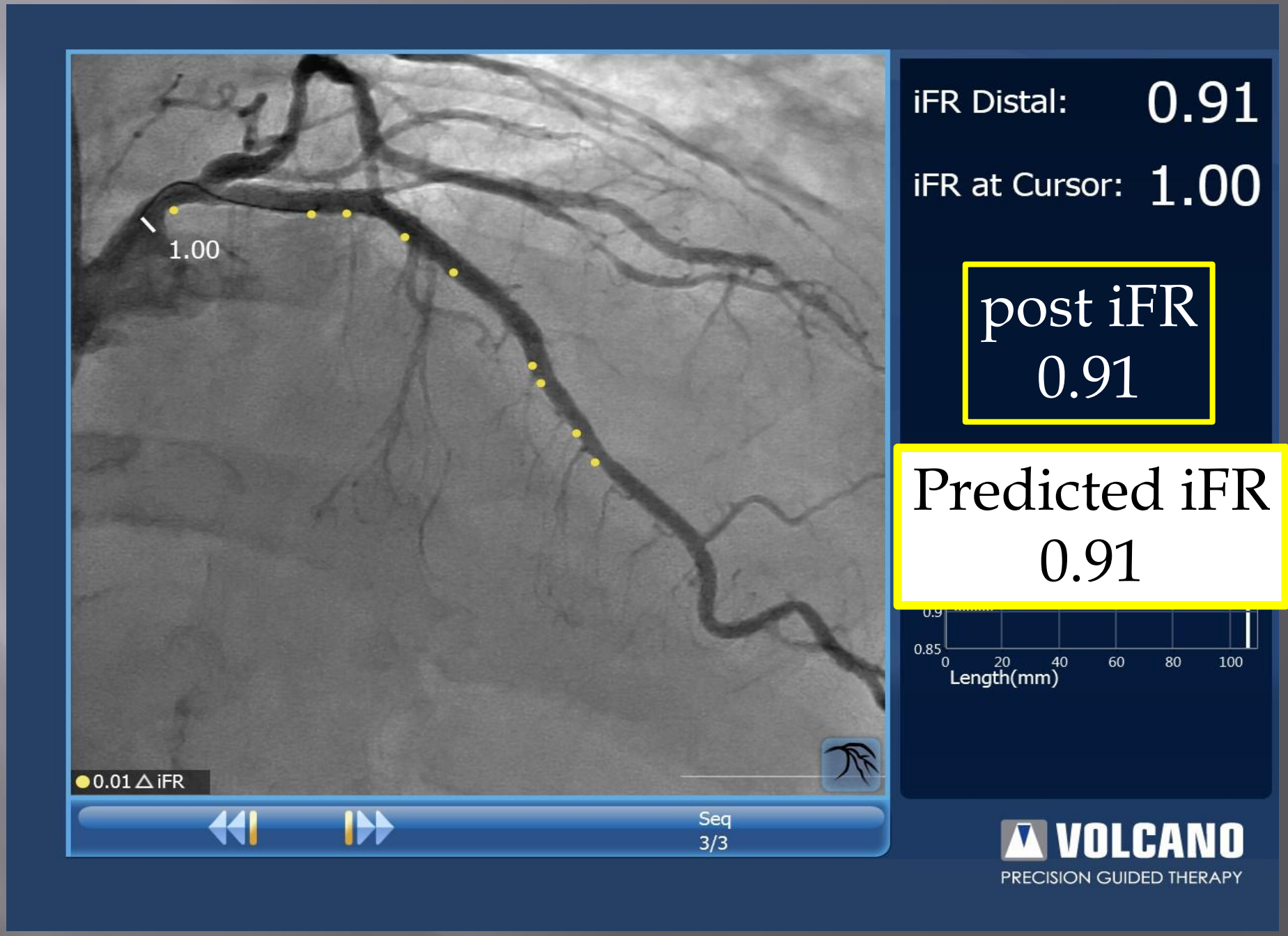
Length: 24.0mm



VOLCANO
PRECISION GUIDED THERAPY


60.5mm
0.01 △ iFR
Seq
1/3
iFR Distal: 0.39
iFR drop
in selection : 0.52
Predicted iFR
0.91
Length: 60.5mm
iFR
1
0.8
0.6
0.4
0
20
40
60
80
100
Length(mm)
VOLCANO
PRECISION GUIDED THERAPY




iFR Distal: 0.91
iFR at Cursor: 1.00
1.00
post iFR
0.91
Predicted iFR
0.91
0.9
0.85
0
20
40
60
80
100
Length(mm)
0.01 △ iFR
Seq
3/3
VOLCANO
PRECISION GUIDED THERAPY

Case KY
63y.o male
ID:430250

Pt was referred to our hospital because of gradually developed dyspnea on Febuary 4th 2018.

Risk factors : DM (HbA1c 10.4), Renal insufficiency (Cr 3.48mg/dl) smoking 40 cigarettes/day

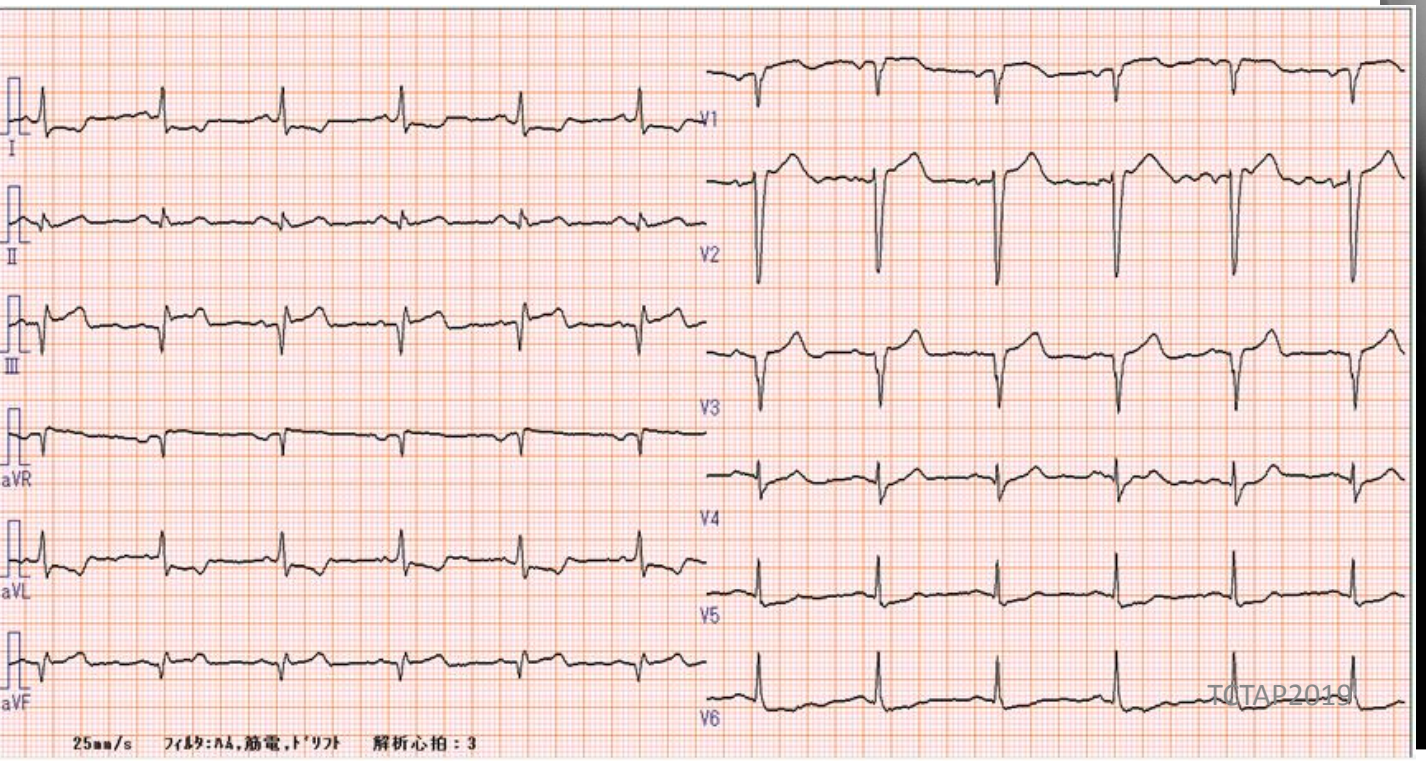
Physical examination SpO2 82% on room air. BP 85/70 HR 90/min

Respiration, Orthopnea with mild wheezing Heart sound : gallop sound was audible

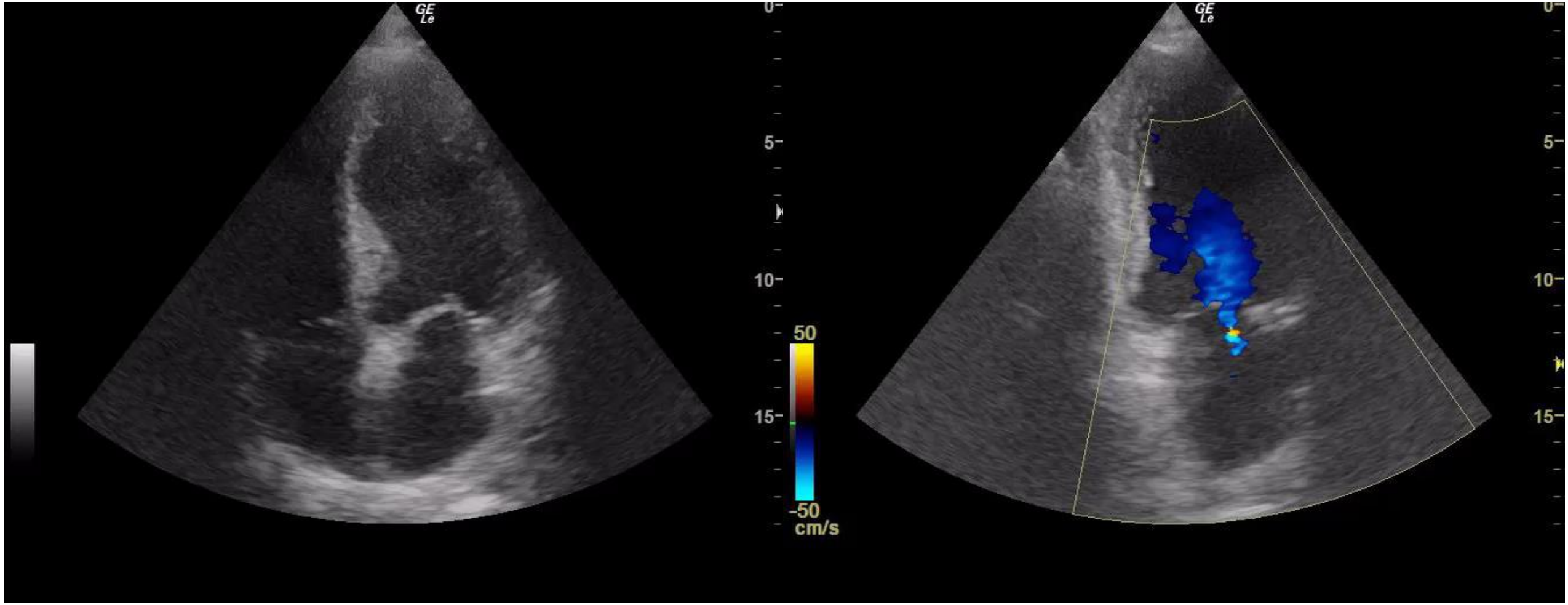
suggestive of heart failure with AMI with undefined onset and concomitant pneumonia.

Pt was immediately treated with BiPAP, intravenous diuretics, HANP and antibiotics(CTRX).

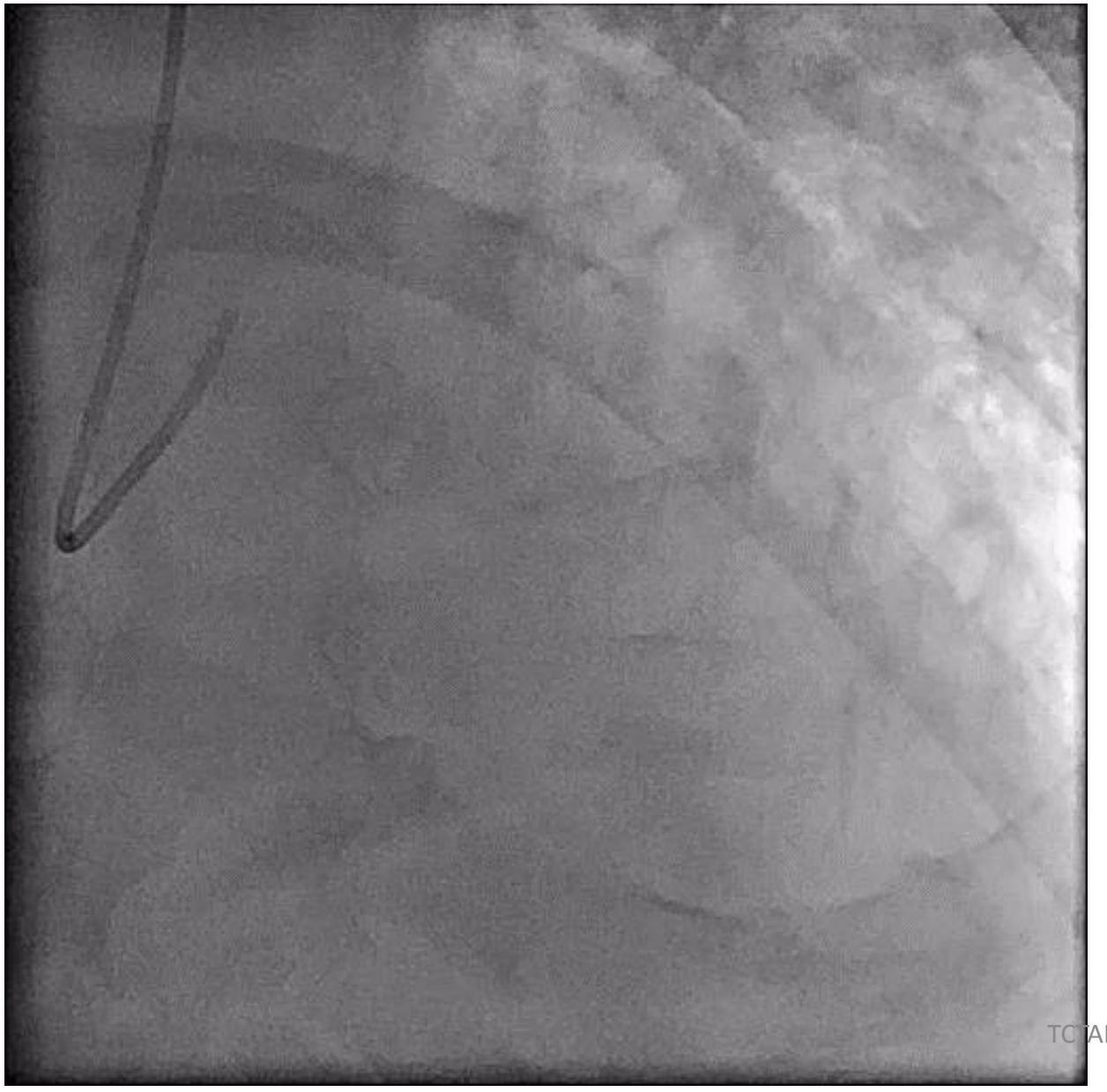
Pt was sent to cath lab to undergo the coronary angiography due to the uncontrollable non-sustained VT storm.

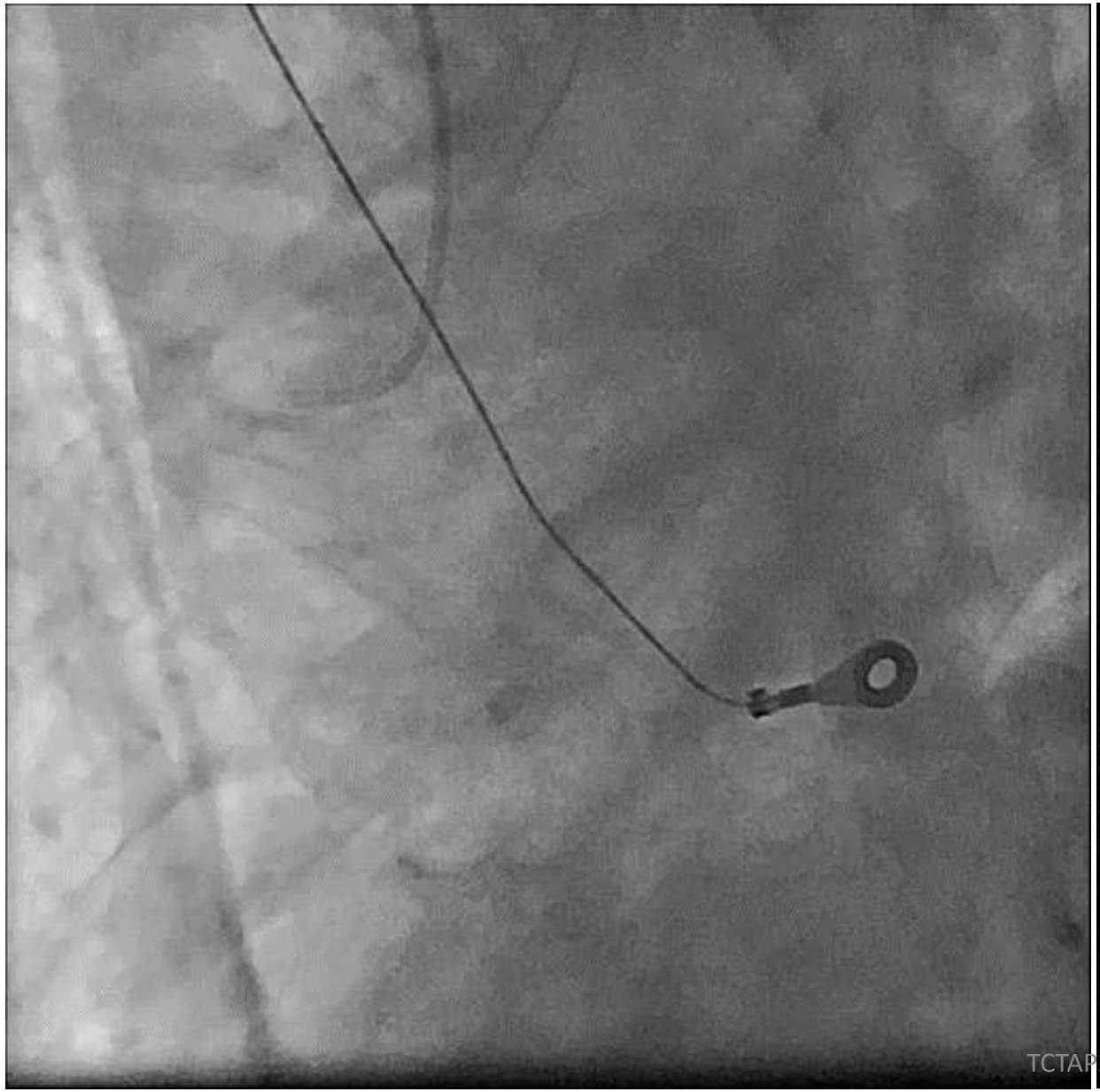

I
II
III
aVR
aVL
aVF
V1
V2
V3
V4
V5
V6
25mm/s
解析心拍：3

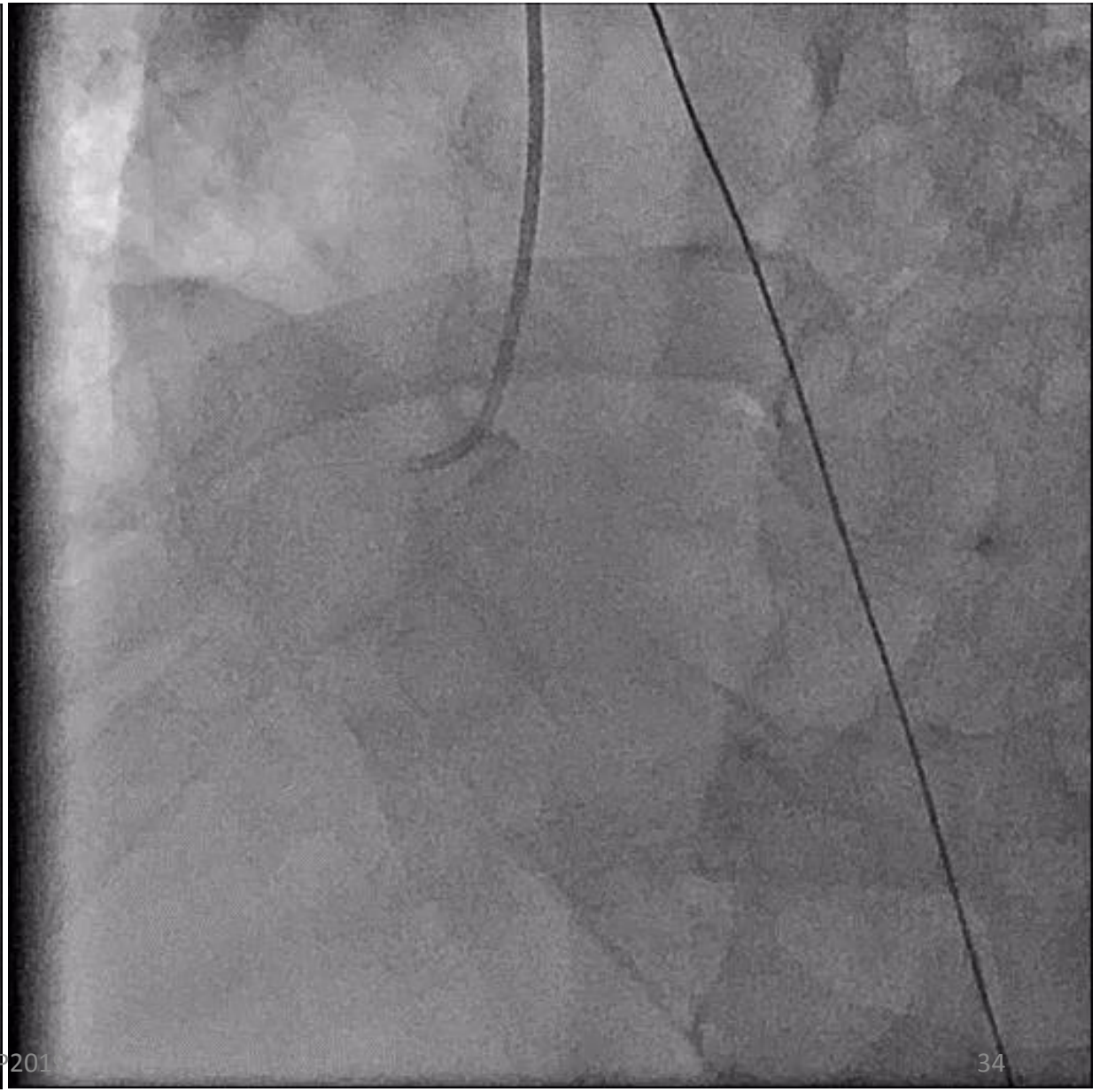
UCG

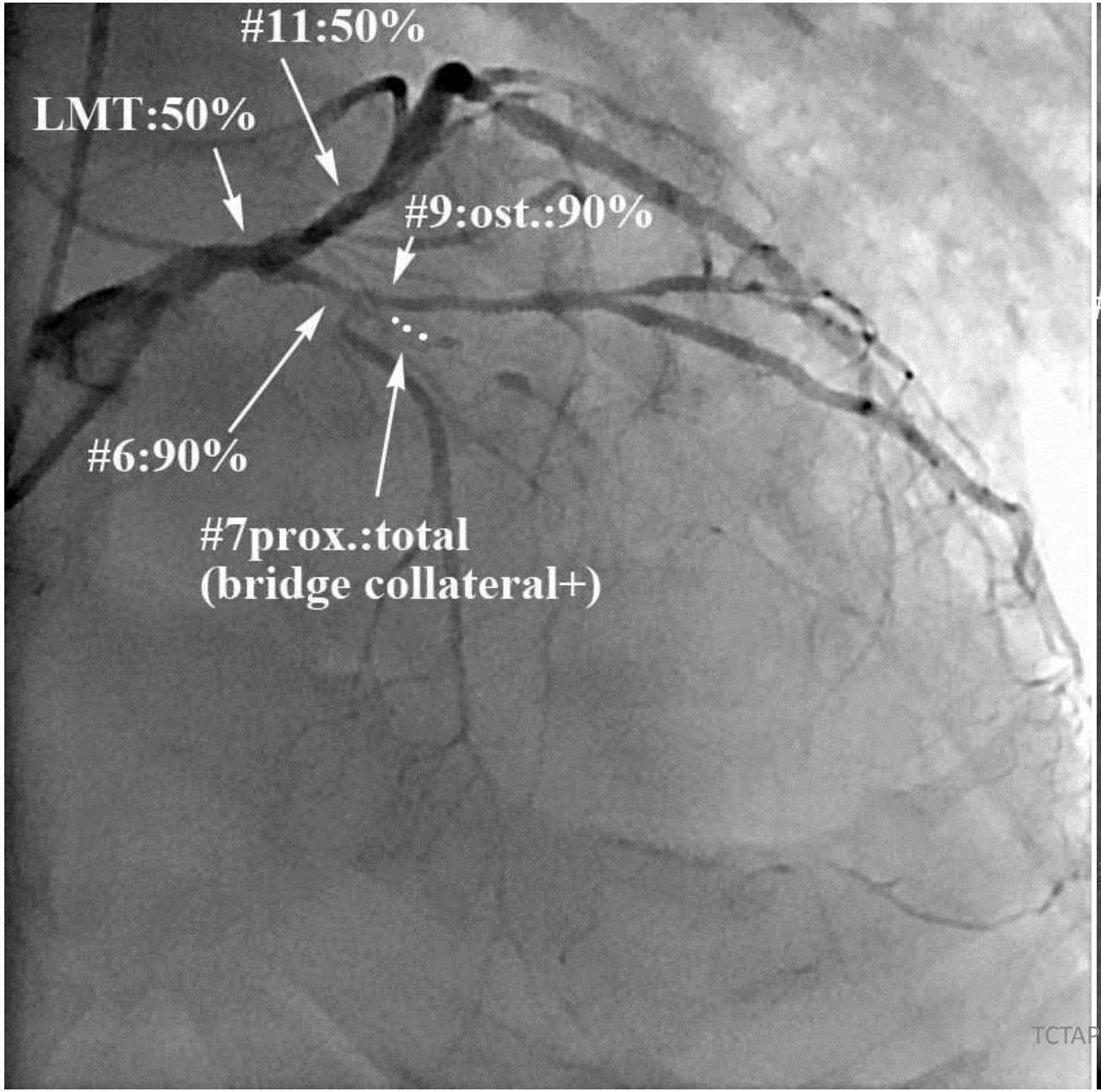


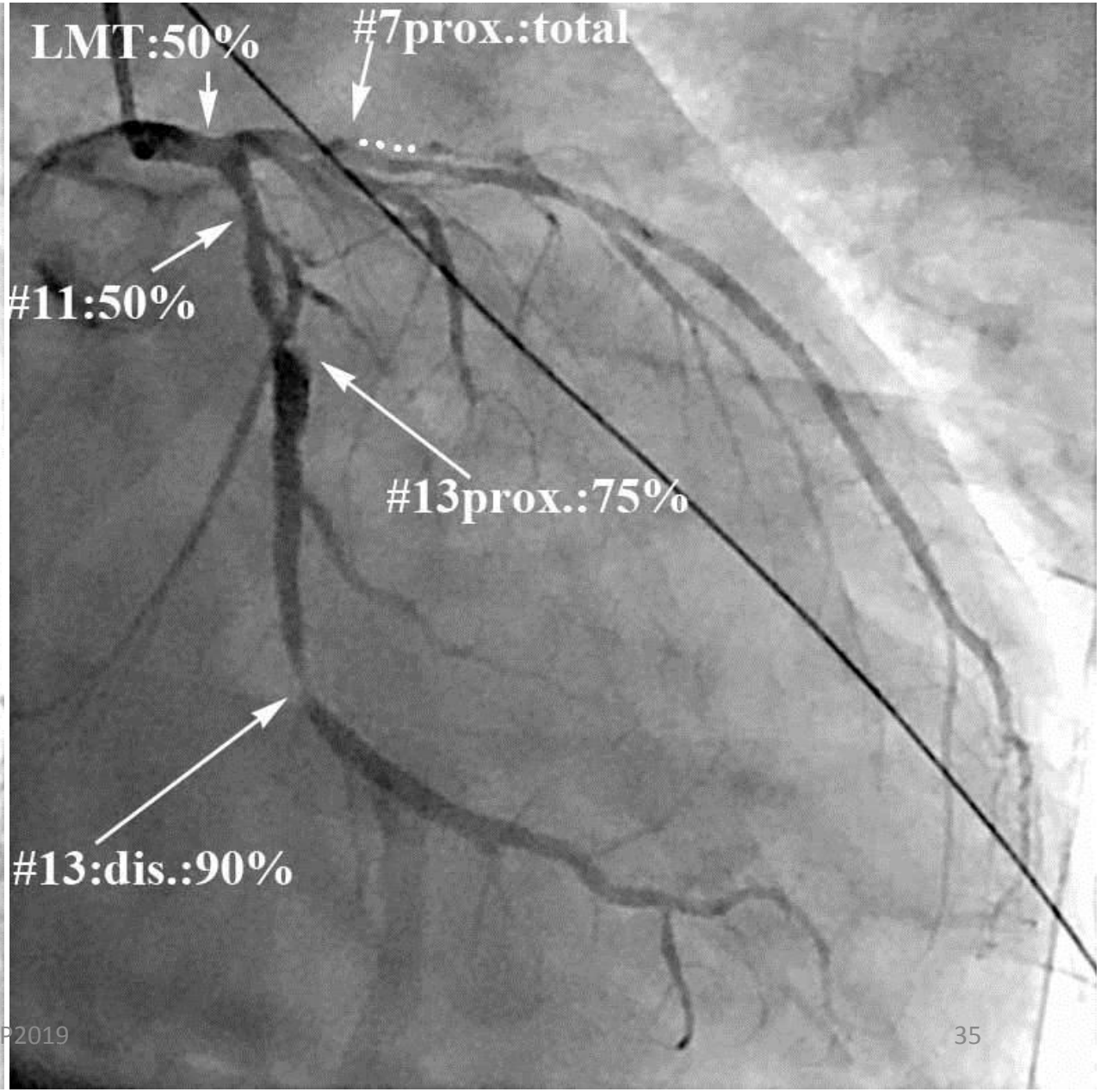
LVEF 38%　LVEDV 124ml LVESV 75ml



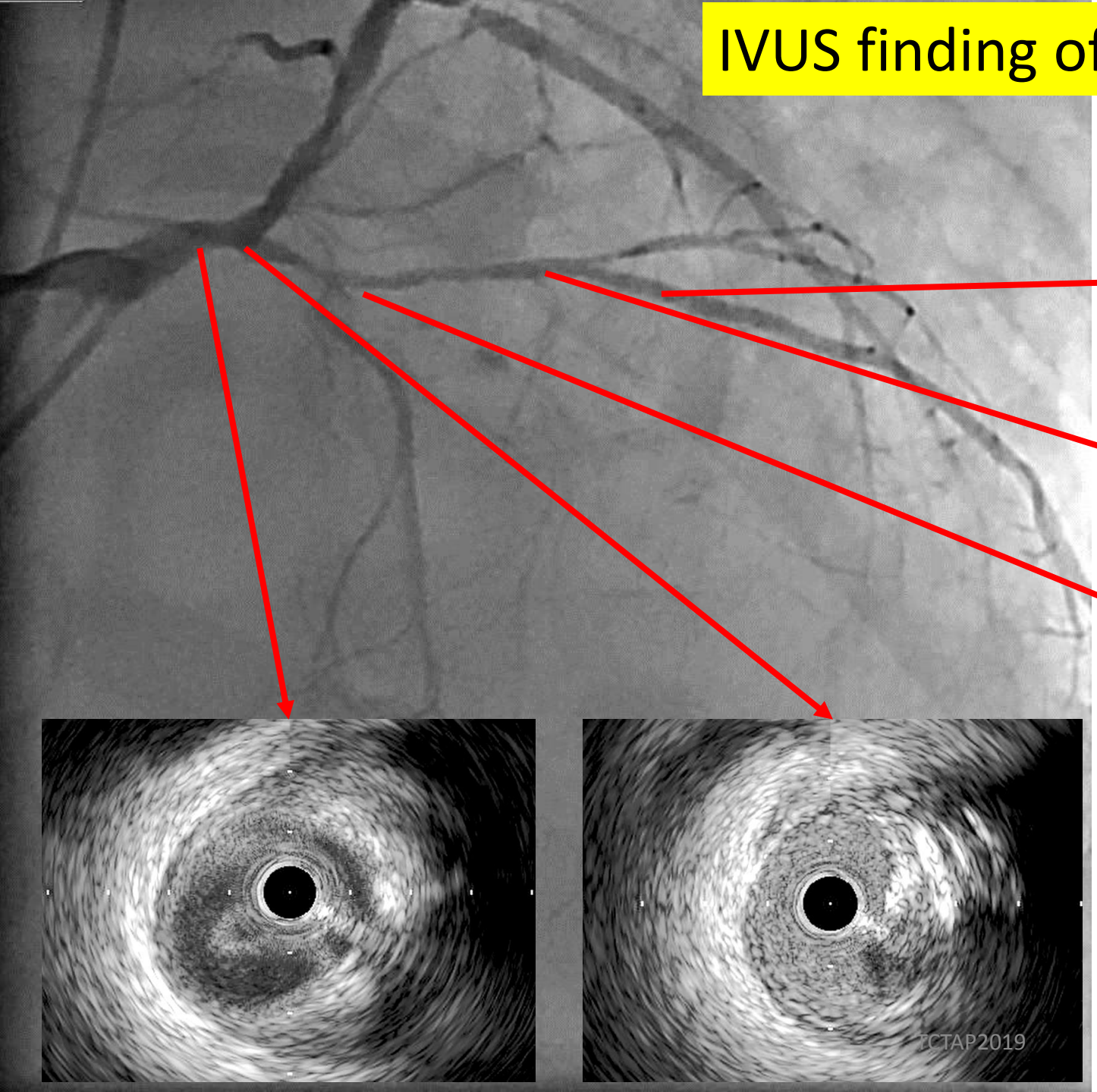


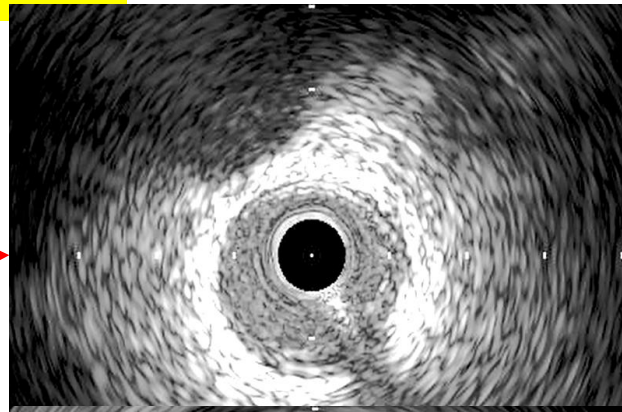


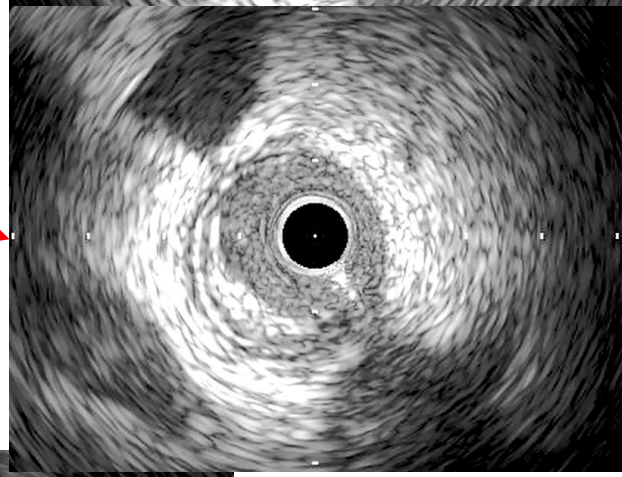

#11:50%
LMT:50%
#9:ost.:90%
#6:90%
#7prox.:total
(bridge collateral+)

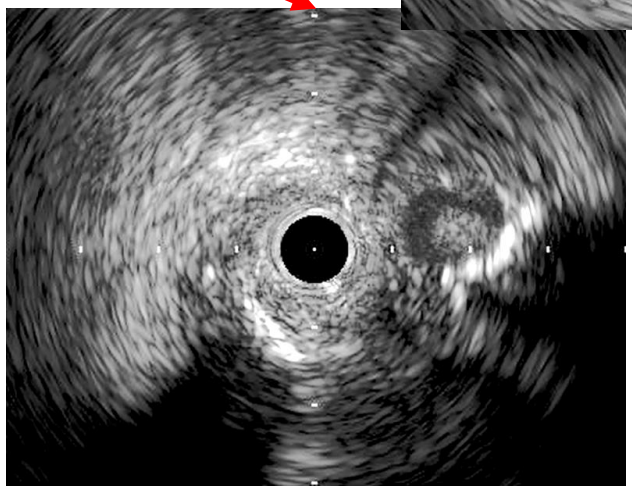

LMT:50%
#7prox.:total
#11:50%
#13prox.:75%
#13:dis.:90%

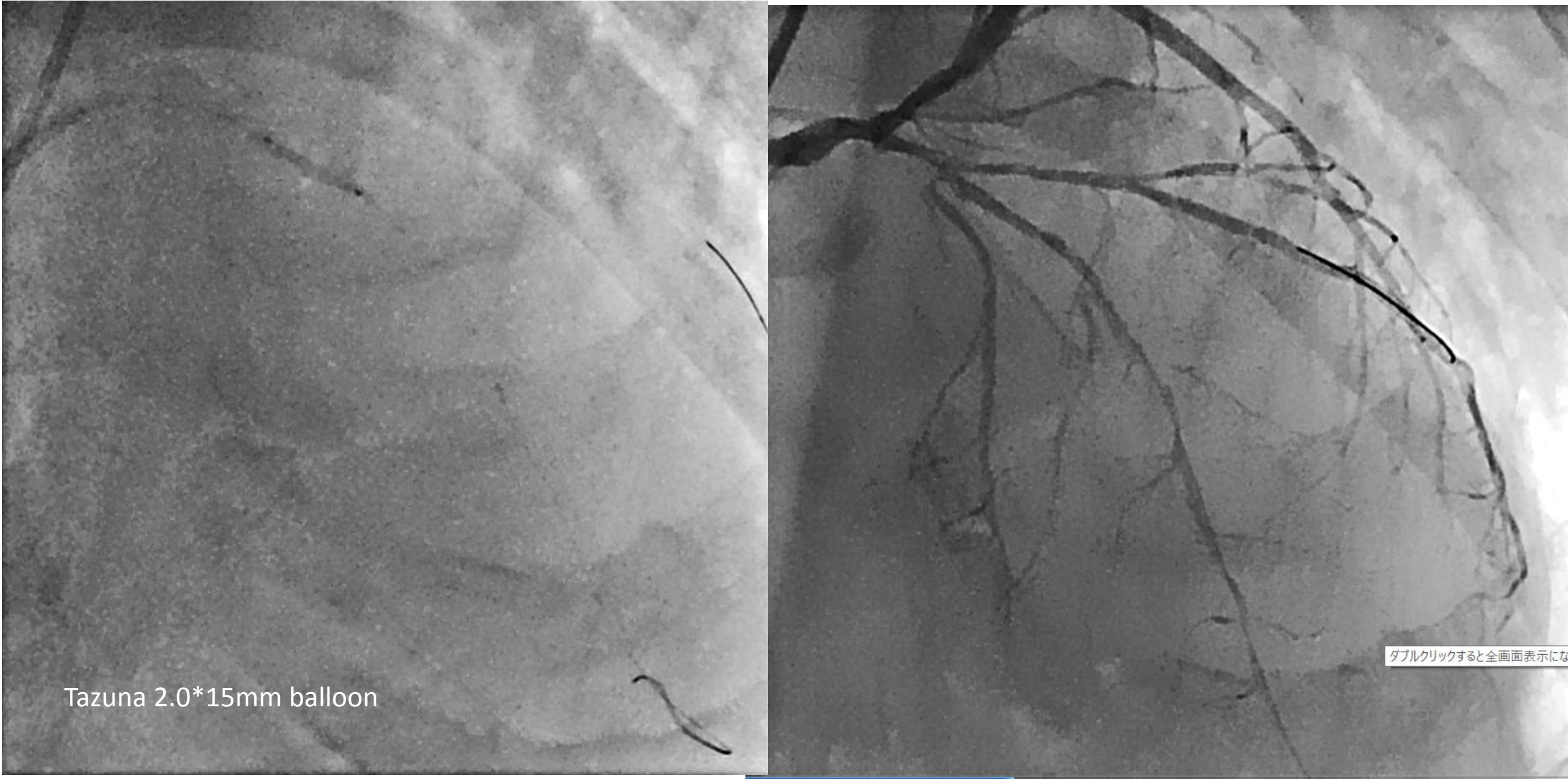
IVUS finding of diagonal branch

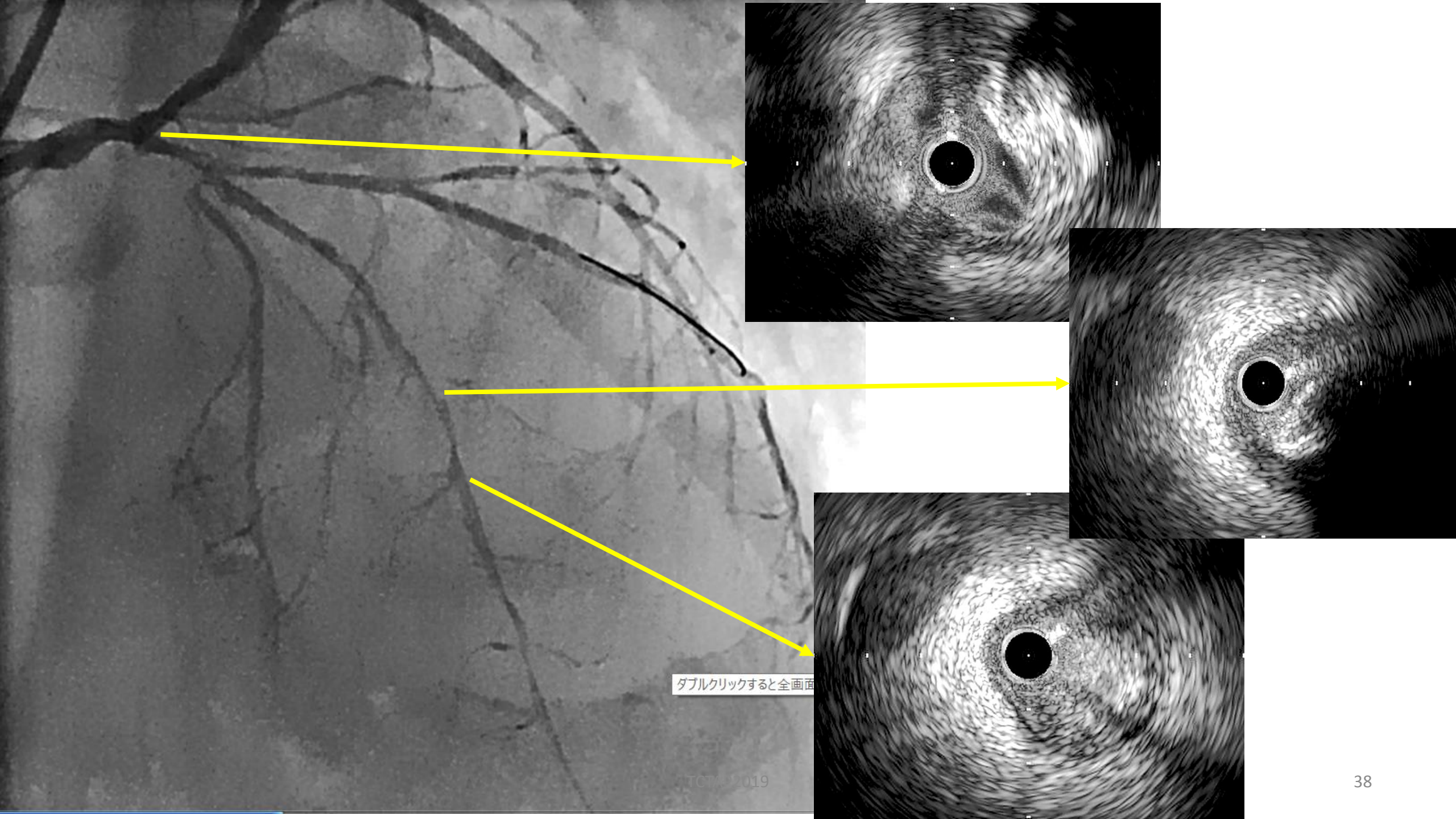


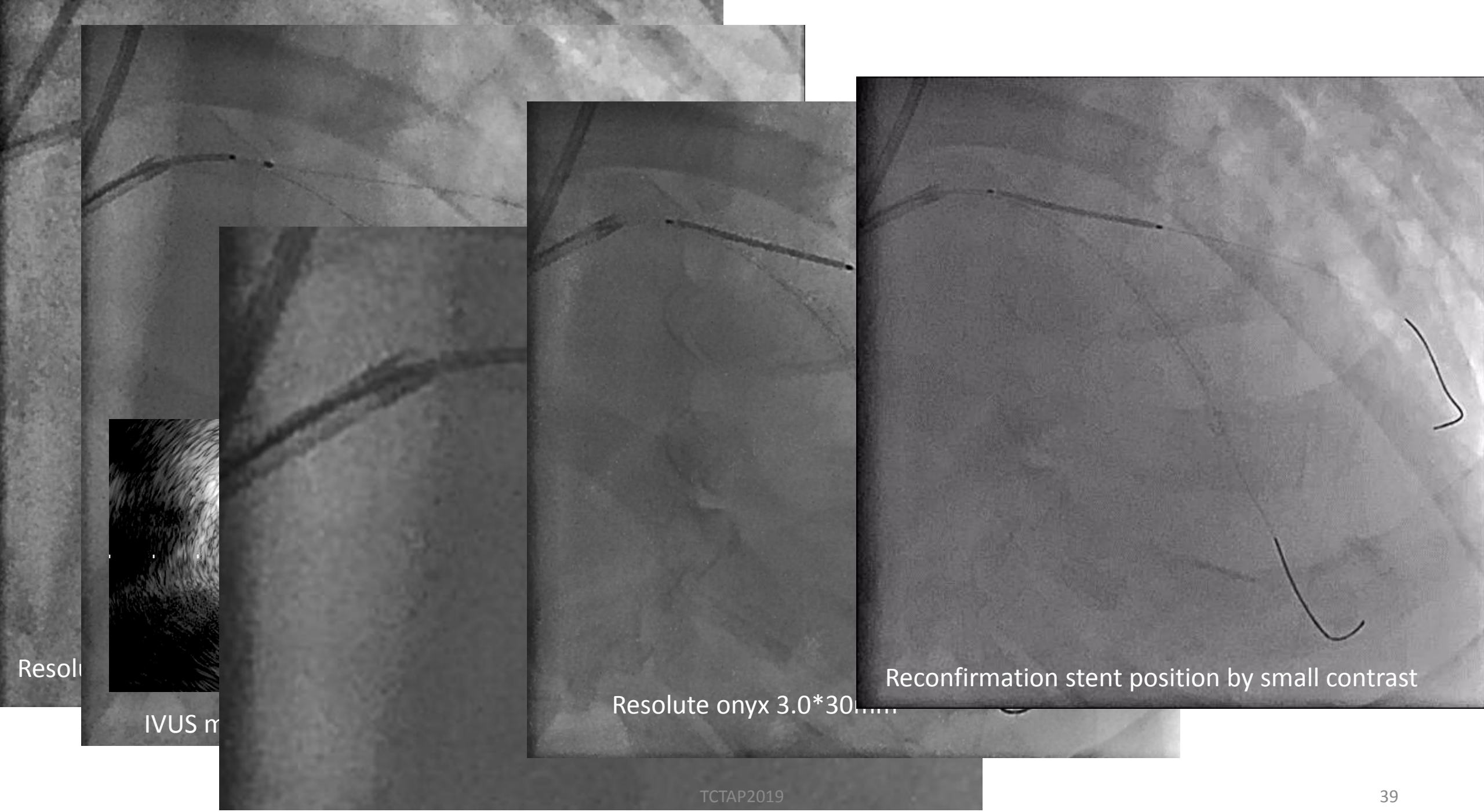


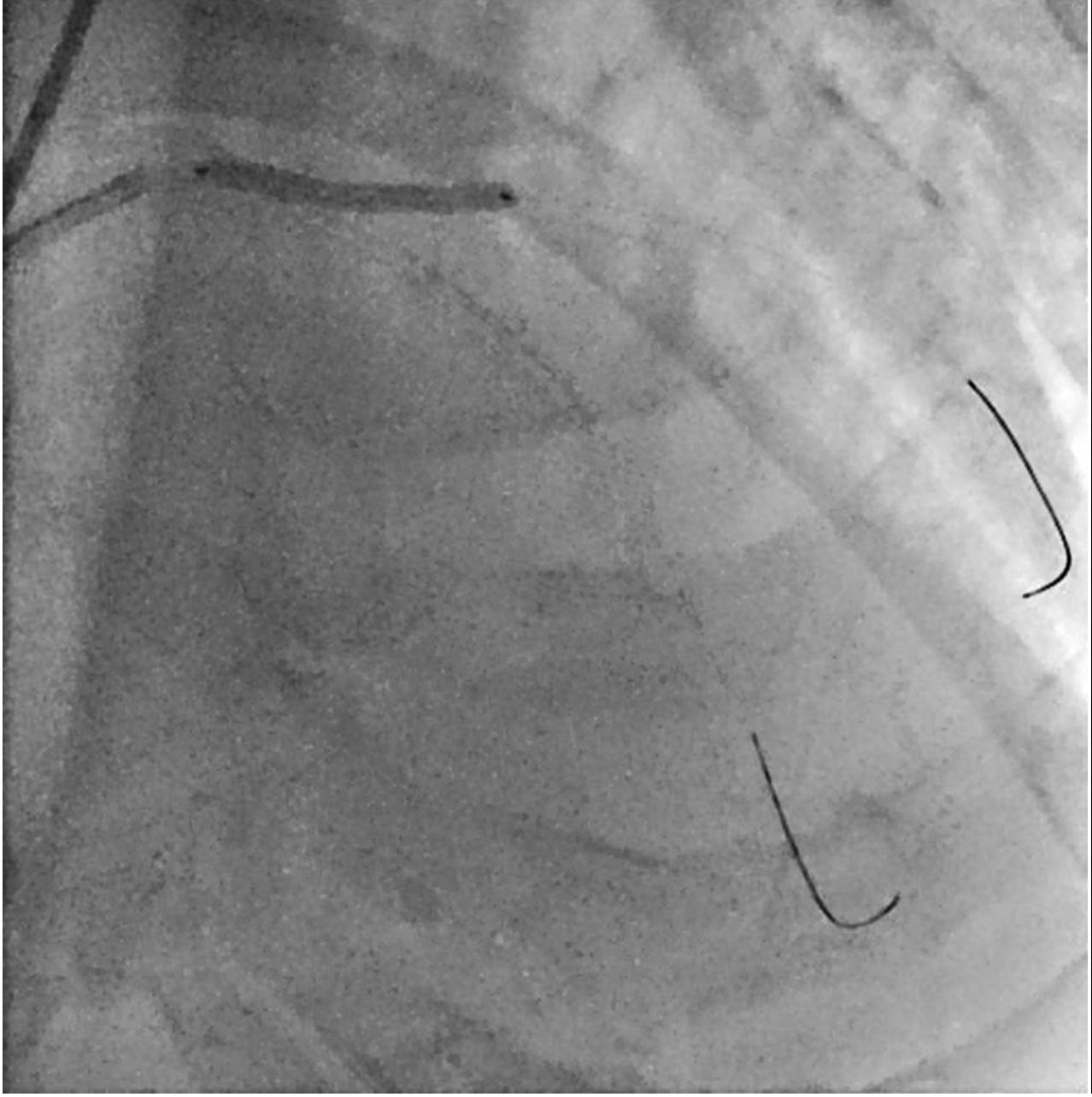


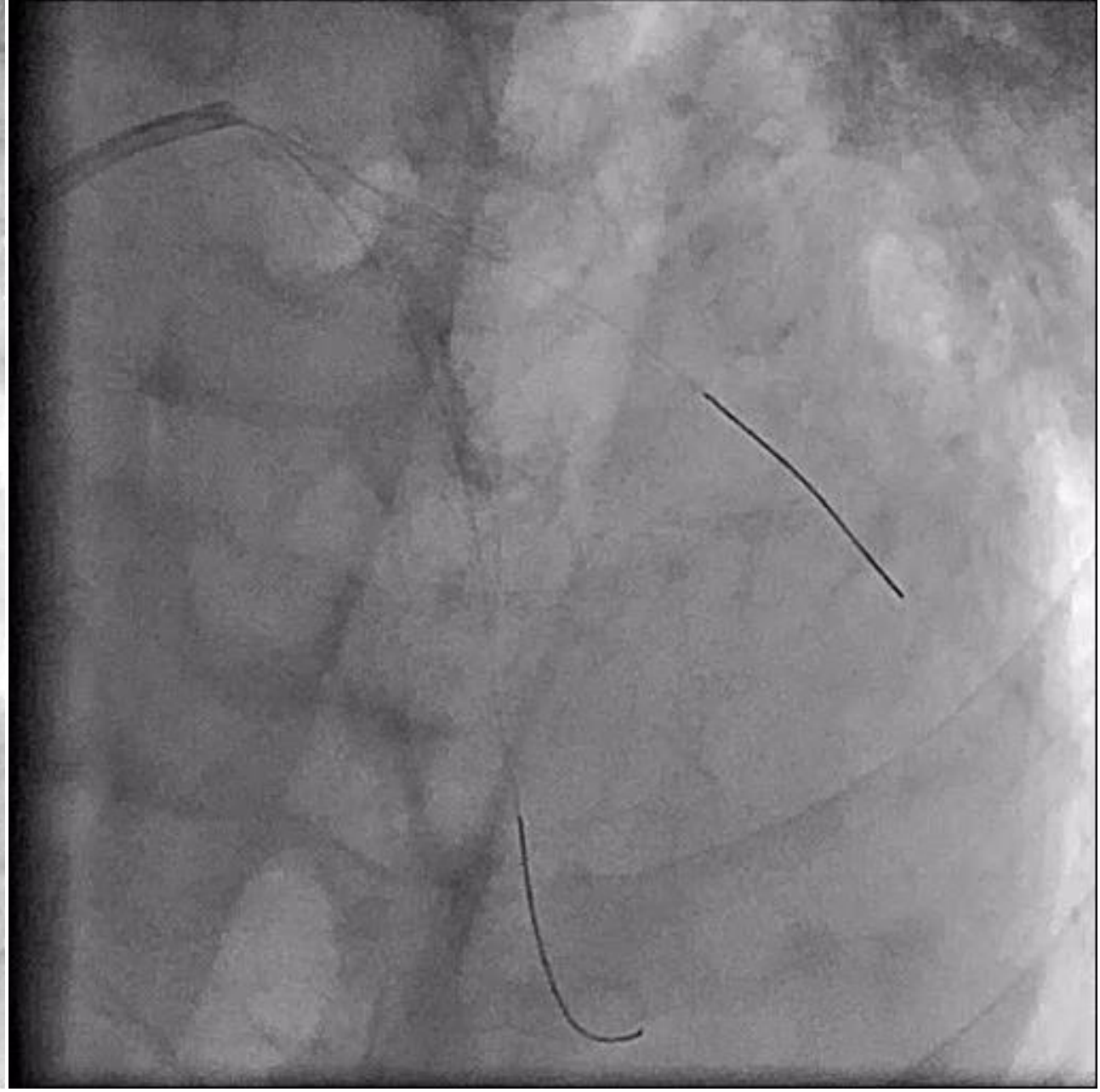


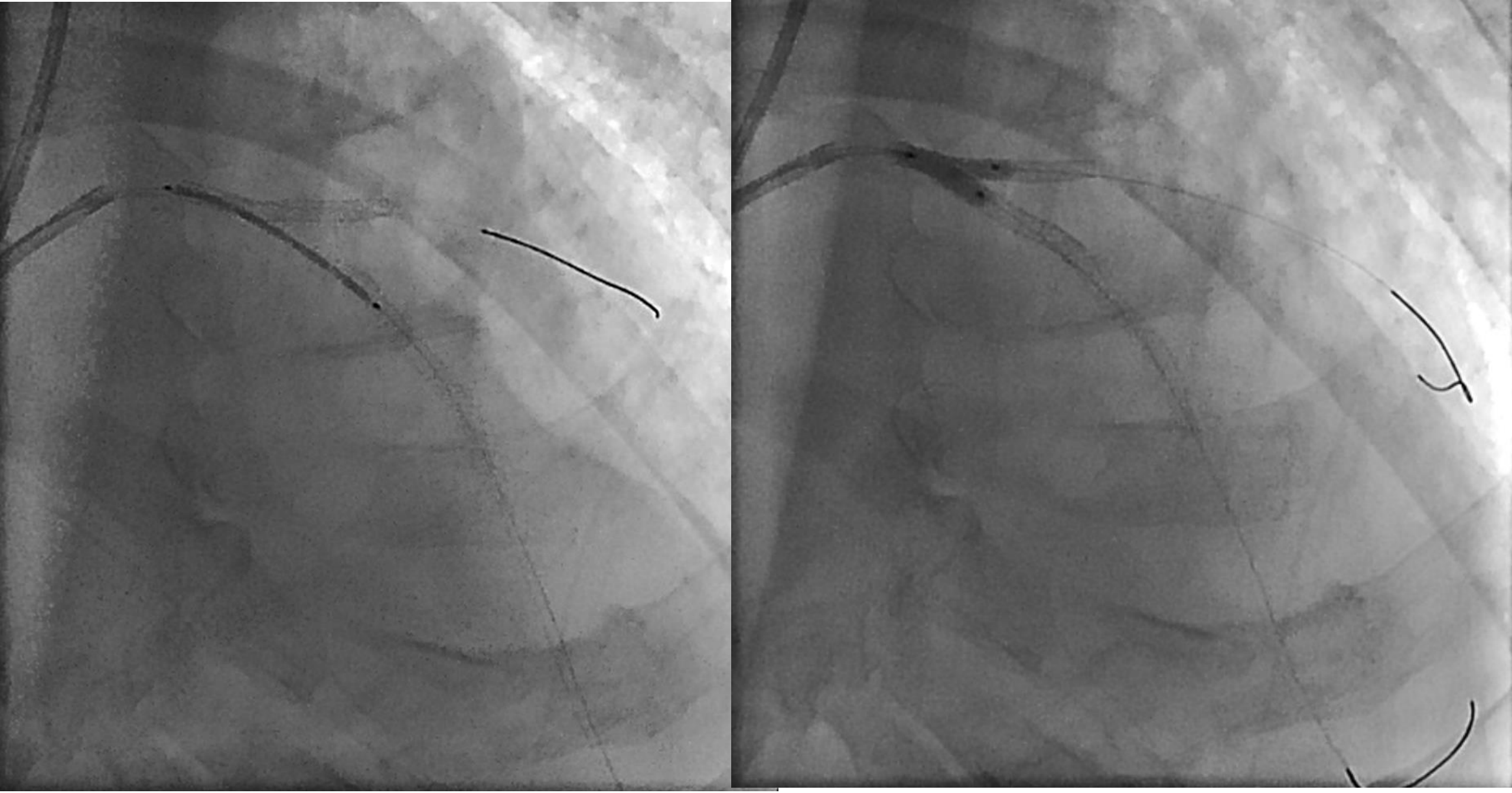

Tazuna 2.0*15mm balloon
ダブルクリックすると全画面表示にな

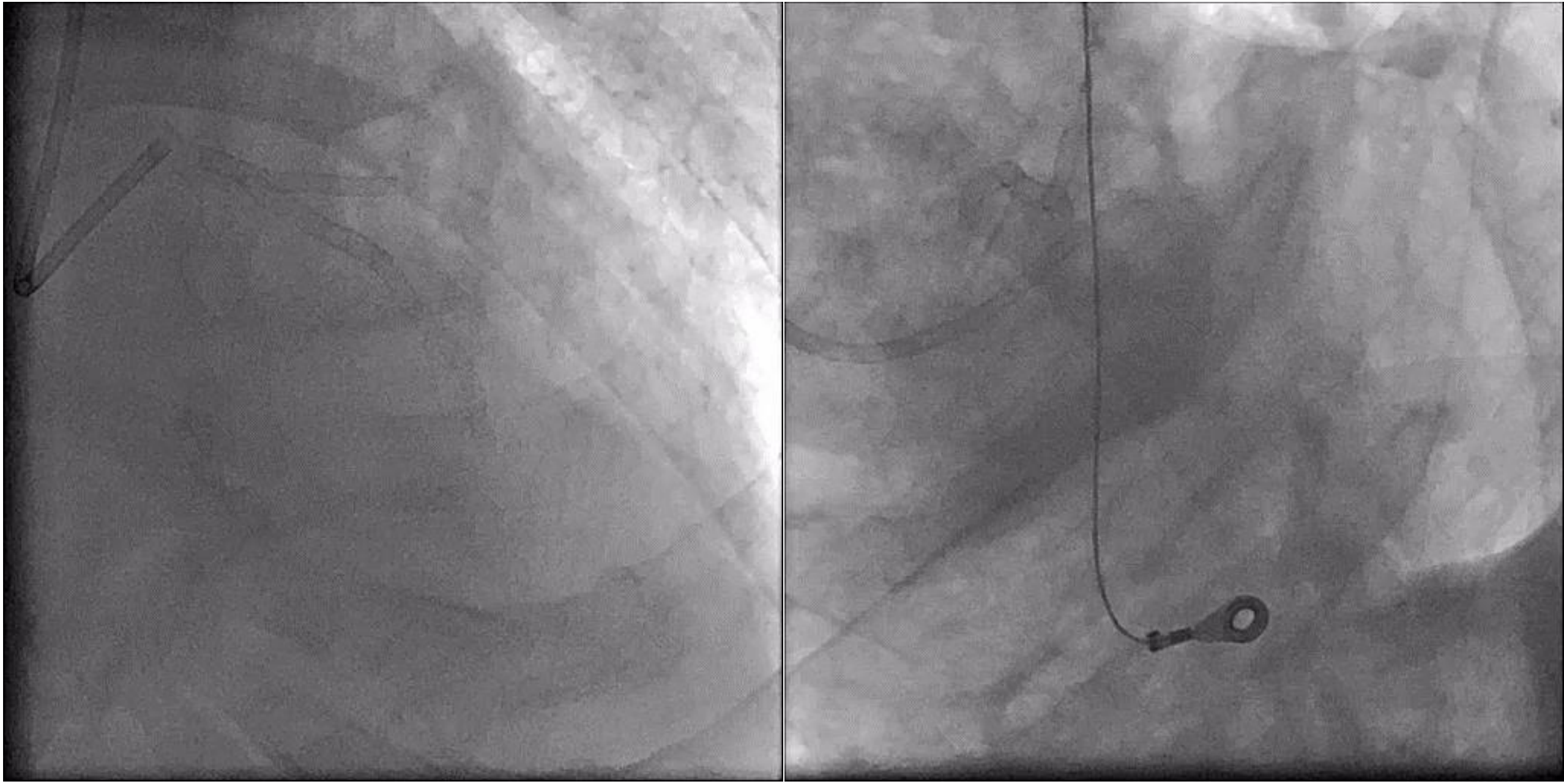

ダブルクリックすると全画面

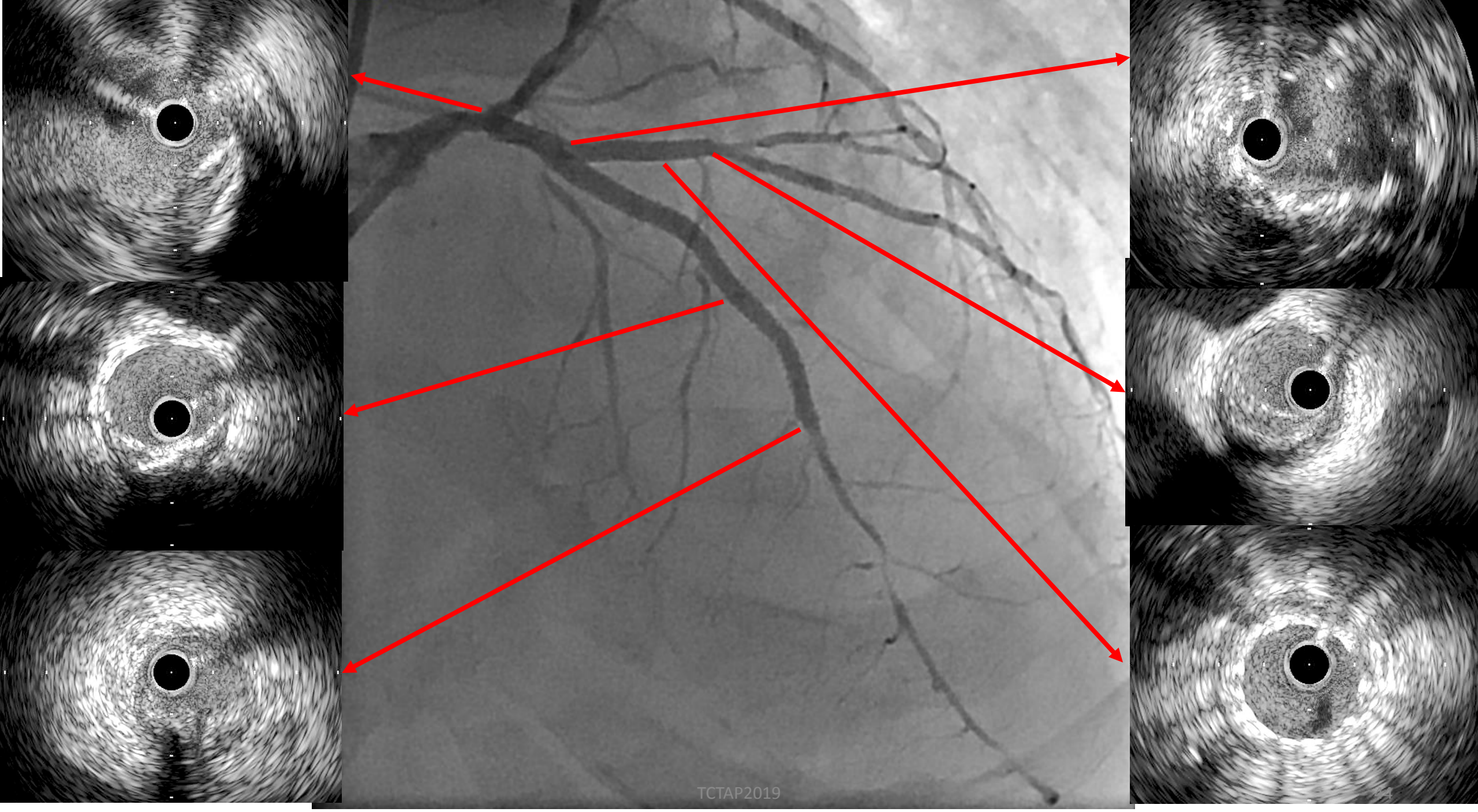

Resolu
IVUS m
Resolute onyx 3.0*30
Reconfirmation stent position by small contrast

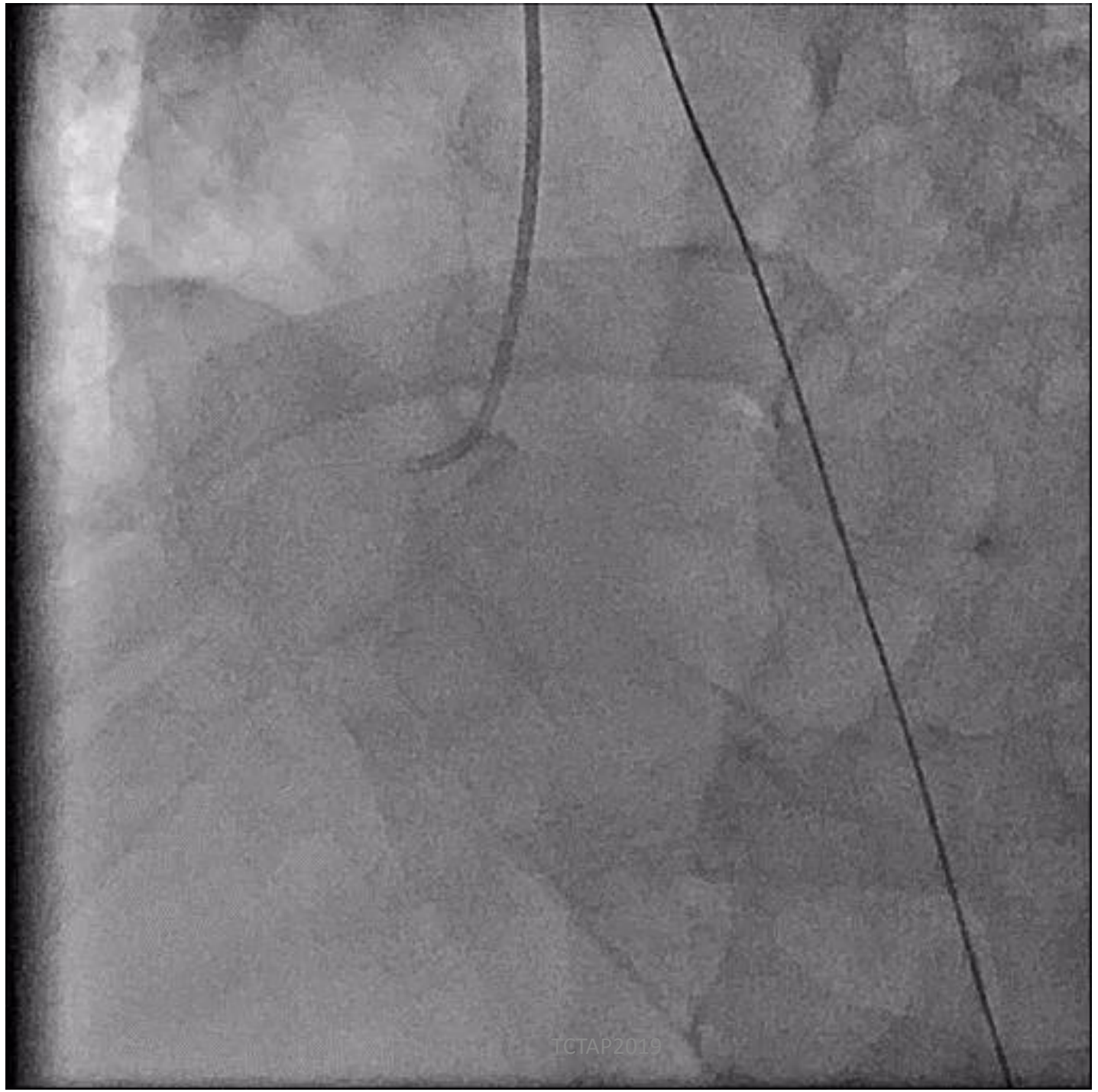


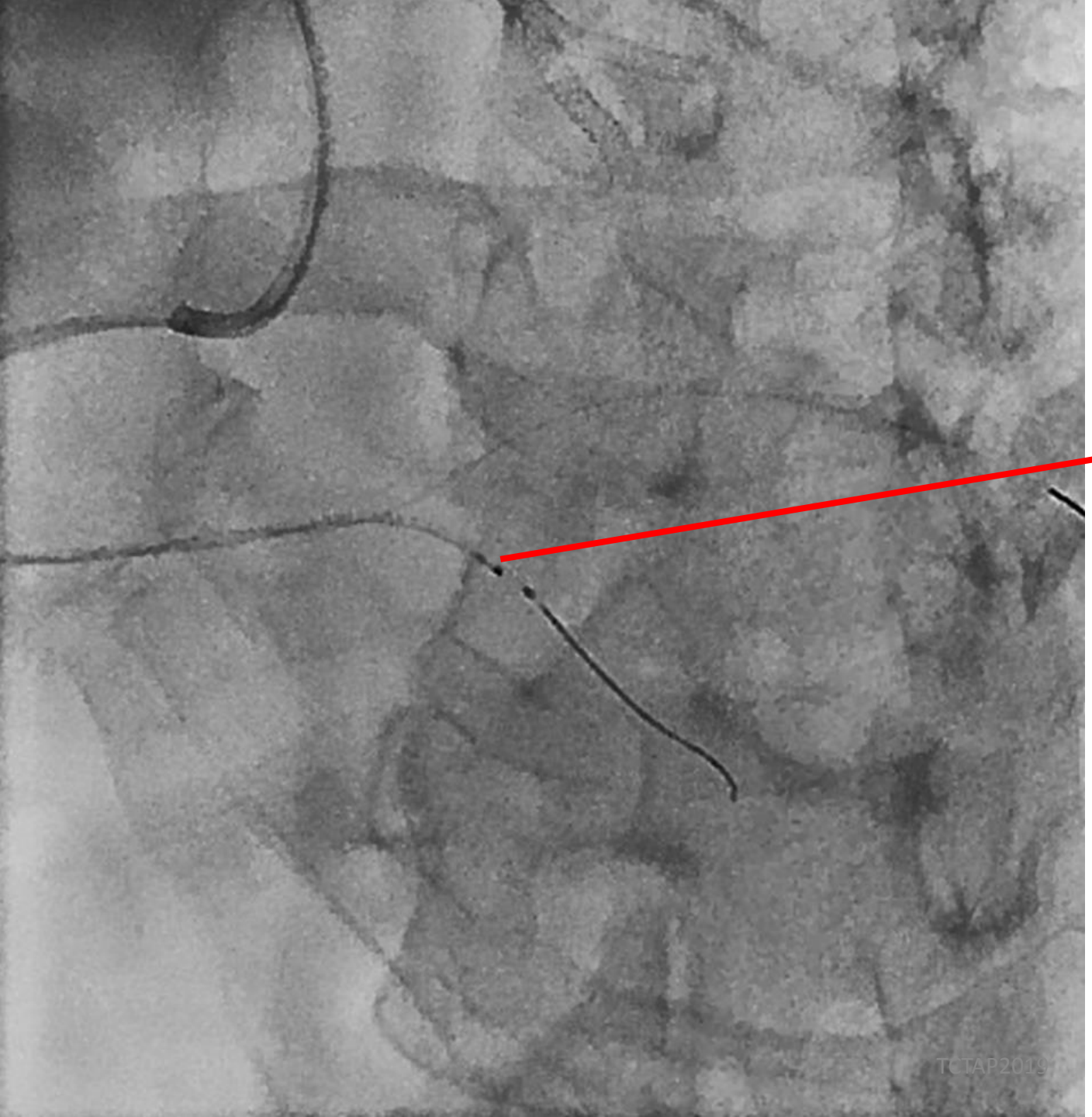


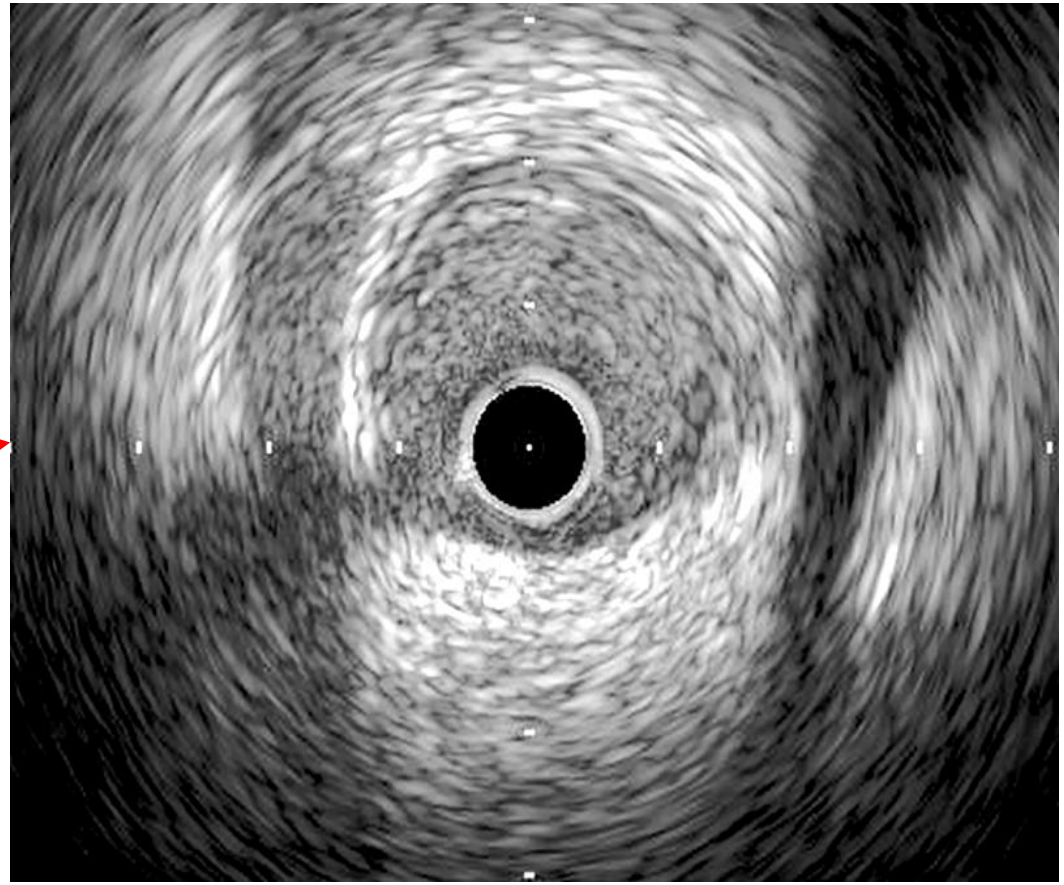


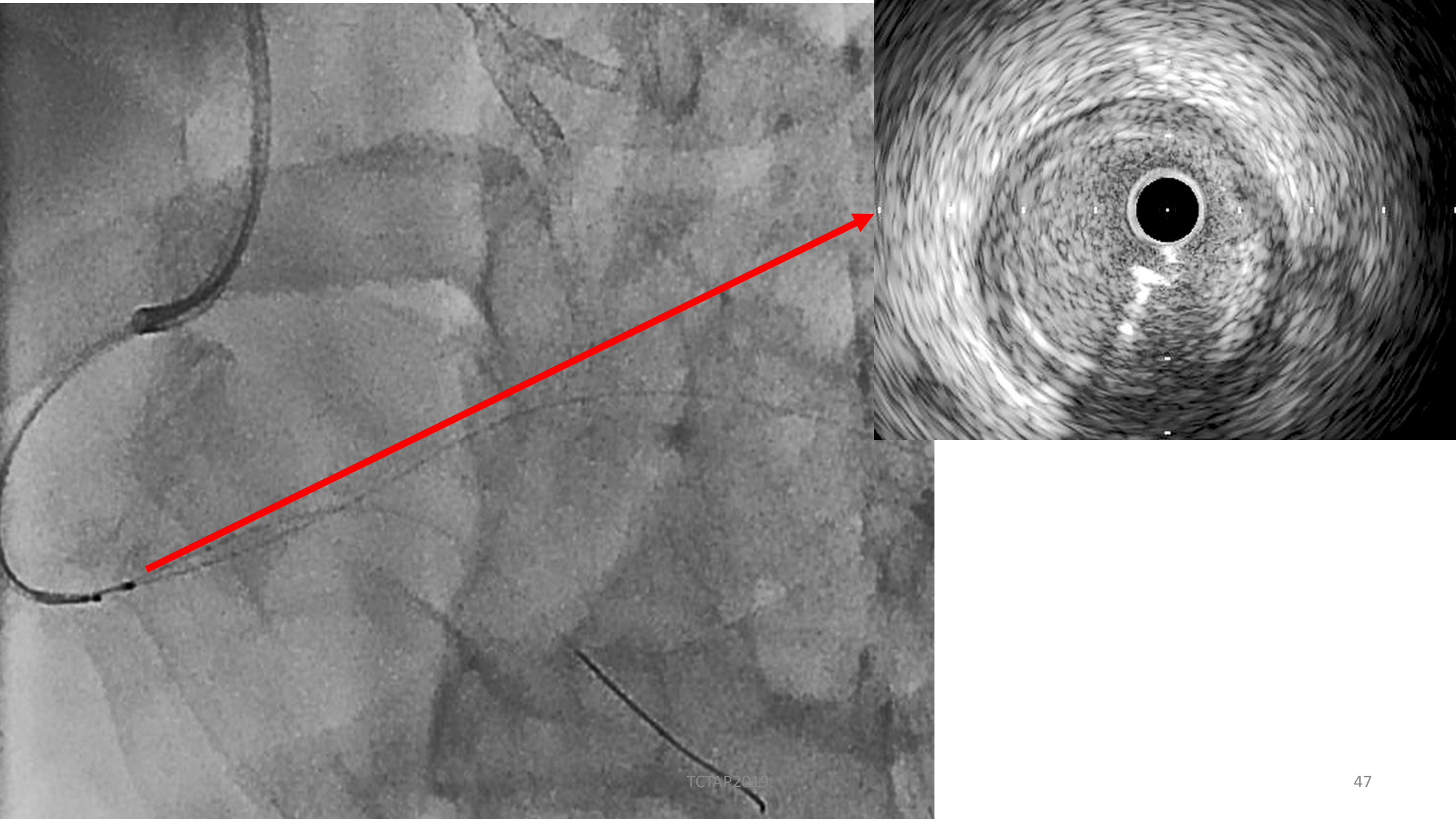


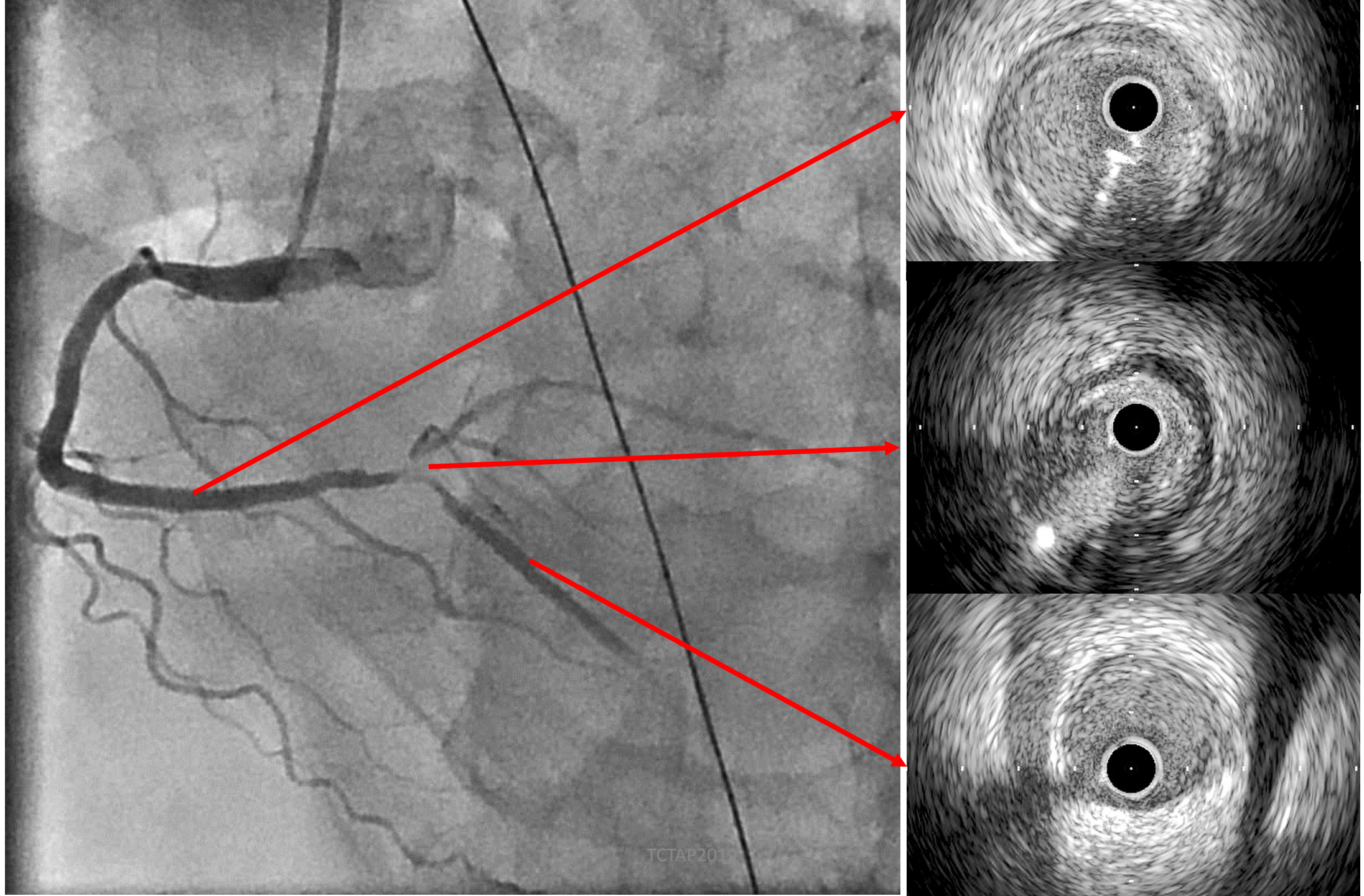

TCTAP2019

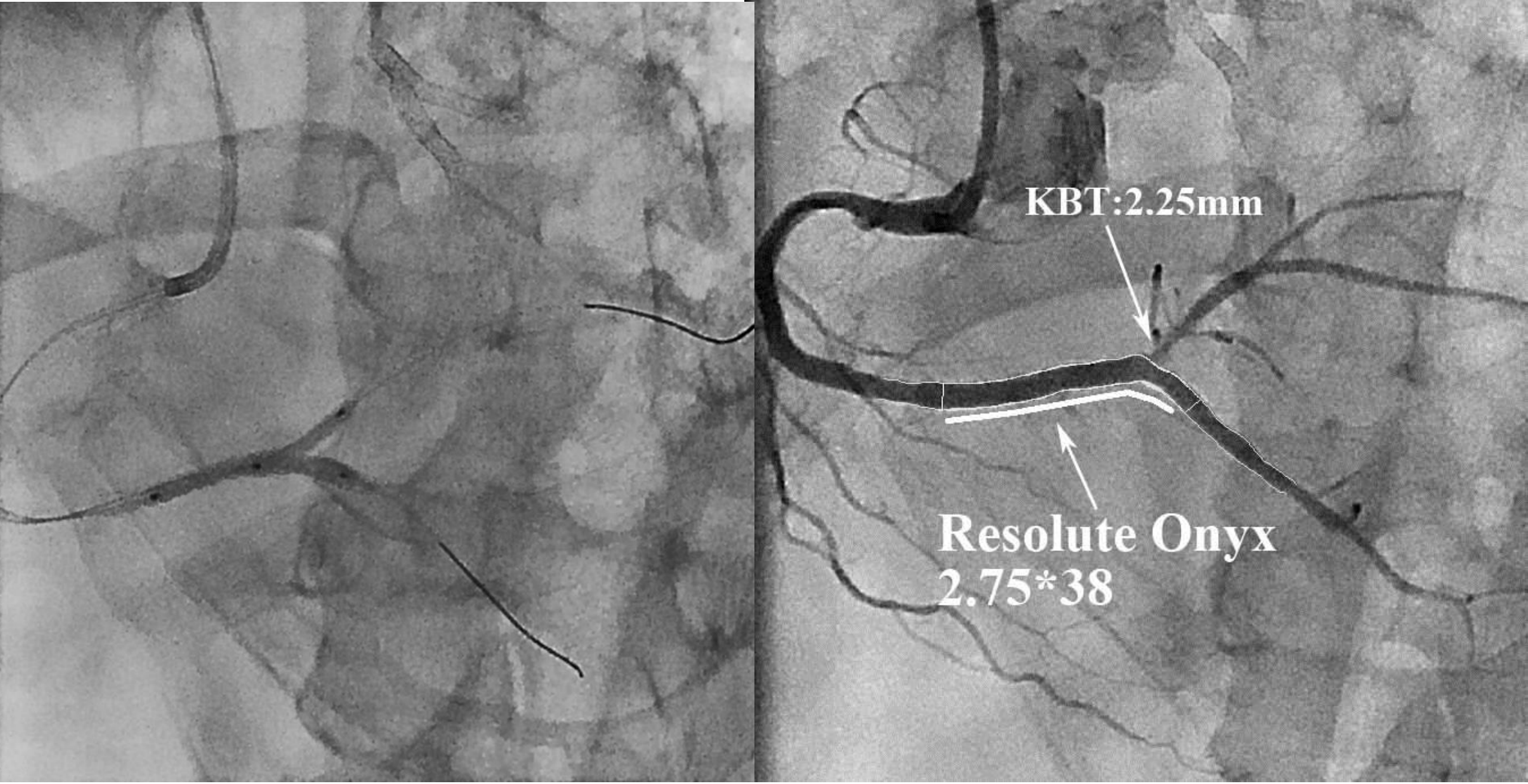


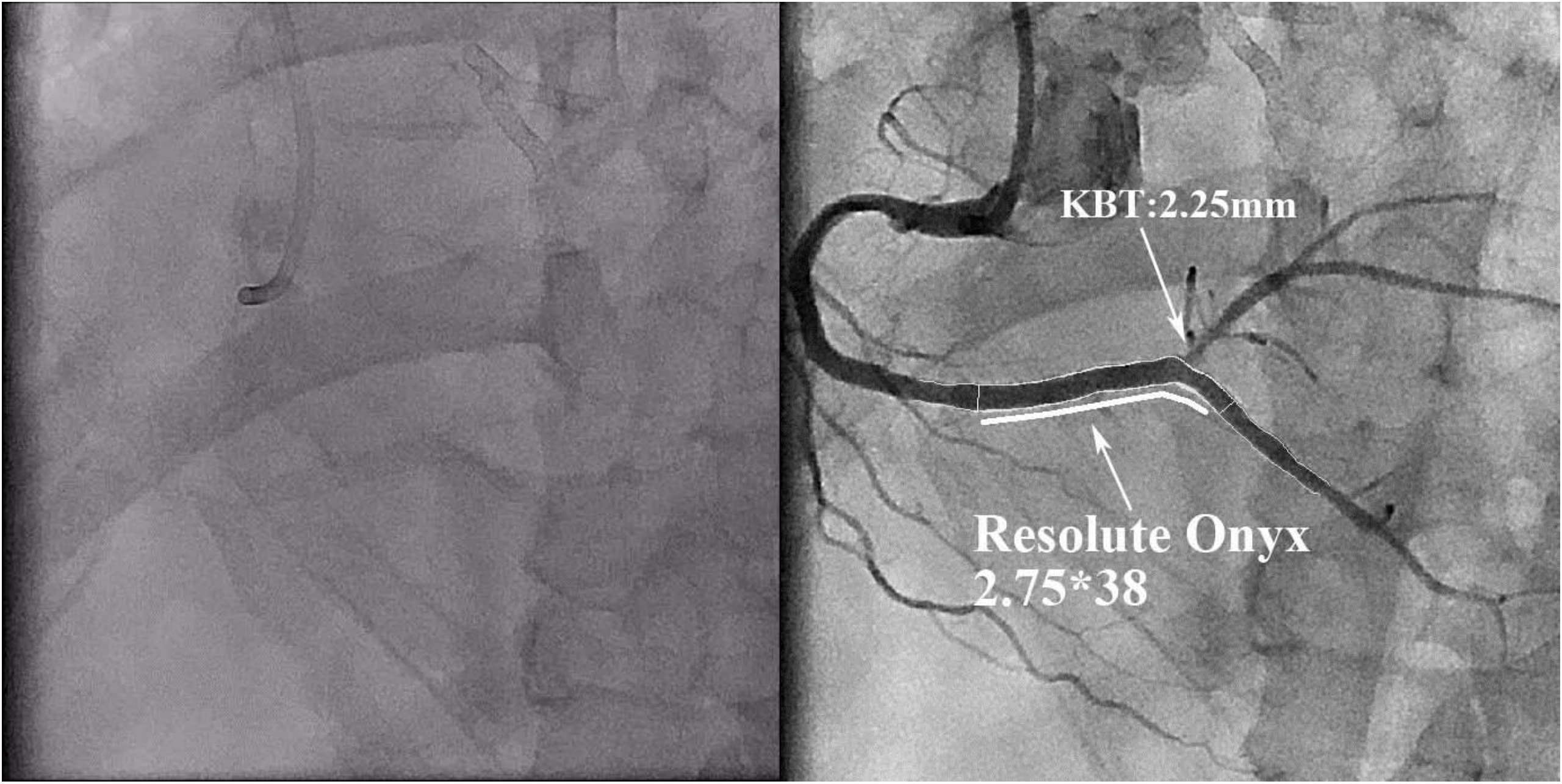


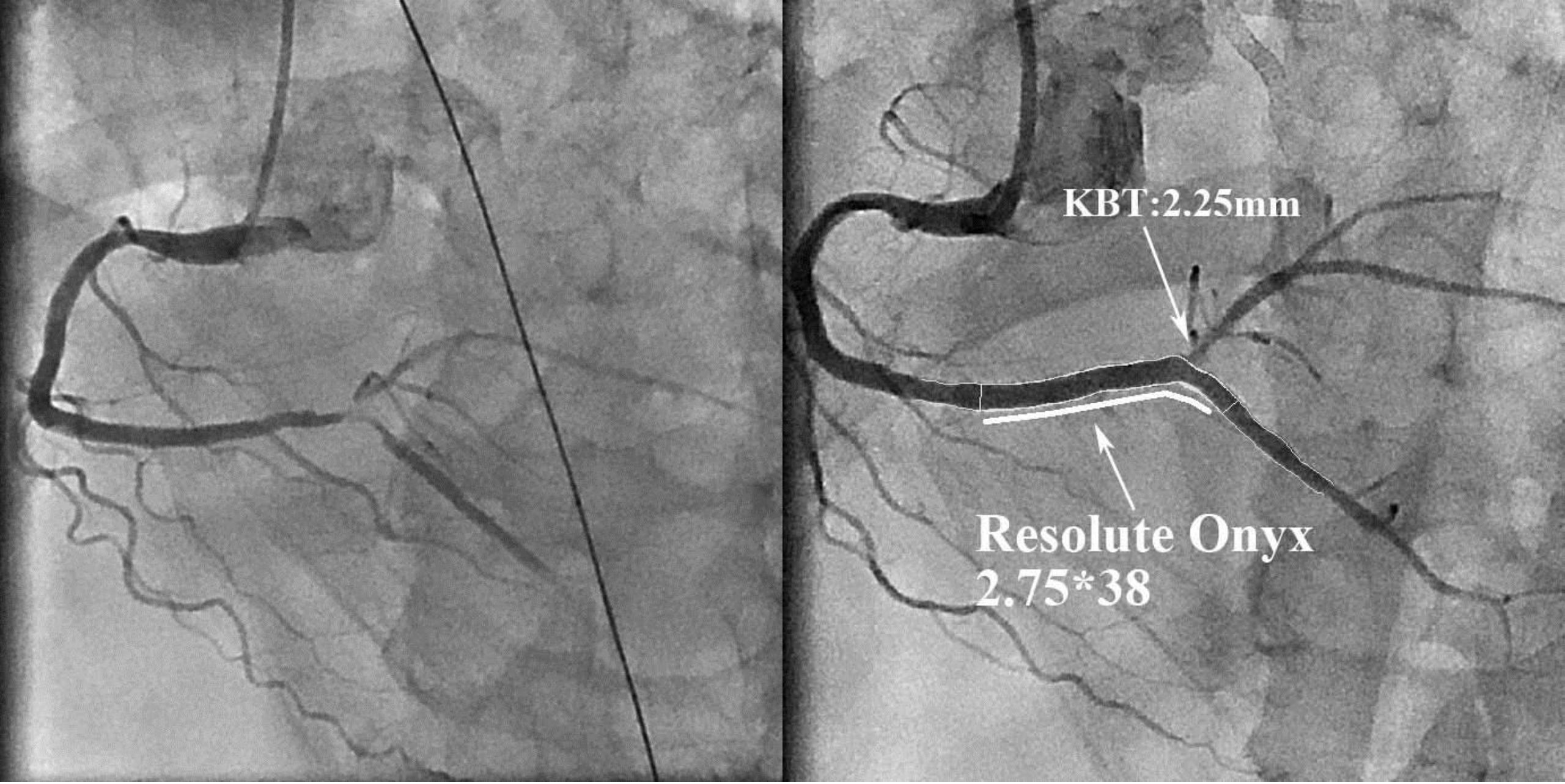







KBT:2.25mm
Resolute Onyx
2.75*38


KBT:2.25mm
Resolute Onyx
2.75*38



The use of contrast was only 50ml for all procedures including LAD CTO and RCA true bifurcation

Conclusions

- When treating diffuse atherosclerotic coronary stenosis, pressure pullback information using FFR or iFR is a key to identify the most effective part of vessels which should be stented.
- Physiology can simplify the complex procedures to diffuse tandem lesion.
- Imaging to diffuse disease clarify the optimal site of Stent landing zone, and canreduce contrast volume.

Thank you for your attention