

Case Report of Thrombus-Containing Lesion : management of large thrombus burden

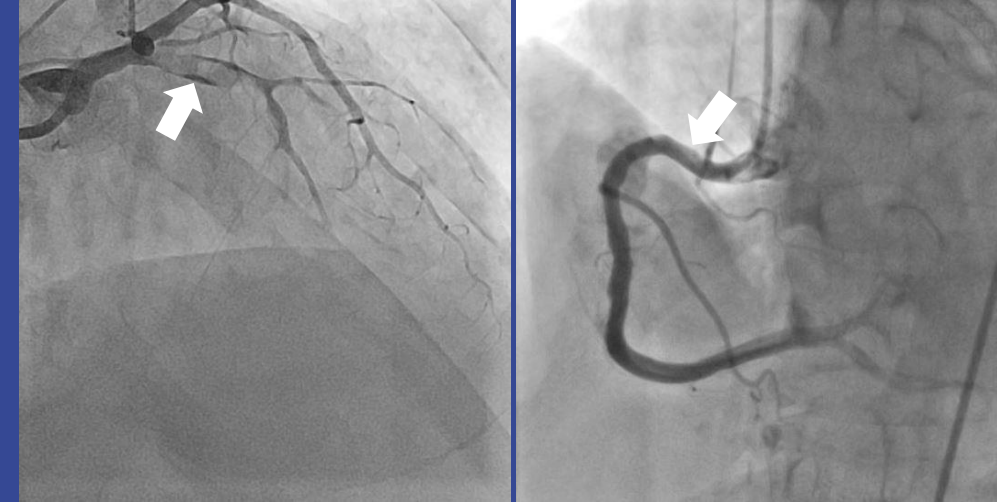
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Coronary thrombus identified in Cath. Lab

- Features in angiography
Haziness and filling defect of contrast



Coronary thrombus identified in Cath. Lab

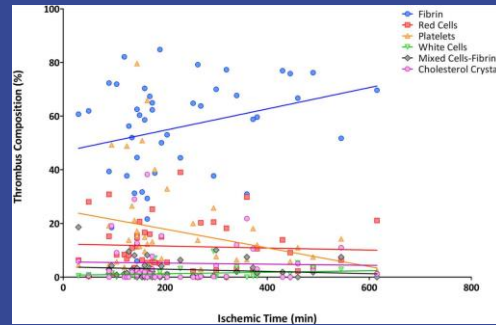
- Features in angiography
Haziness and filling defect of contrast
- Features in imaging : intra-luminal mobile mass

IVUS pattern of thrombus varies depending on composition

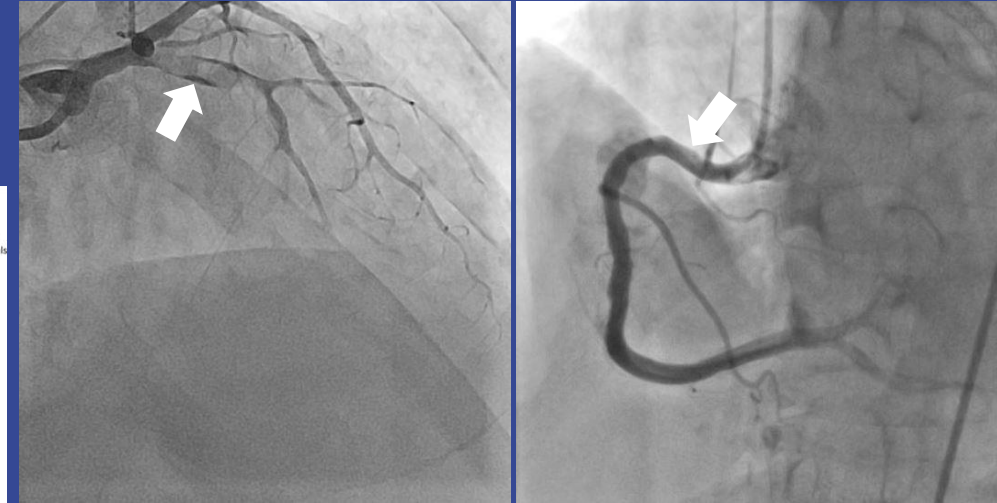
Over time, composition ratio changes%
(increase fibrin, decrease platelet, constant RBC)

Depending on RBC capture
White thrombus(Platelet-rich)
vs. Red thrombus(RBC+Fibrin, RBC trapped in fibrin network)

Typical thrombus(RBC+Fibrin) pattern in STEMI



Composition of Coronary Thrombus in Acute Myocardial Infarction
Journal of the American College of Cardiology
Volume 57, Issue 12, 22 March 2011, Pages 1359-1367

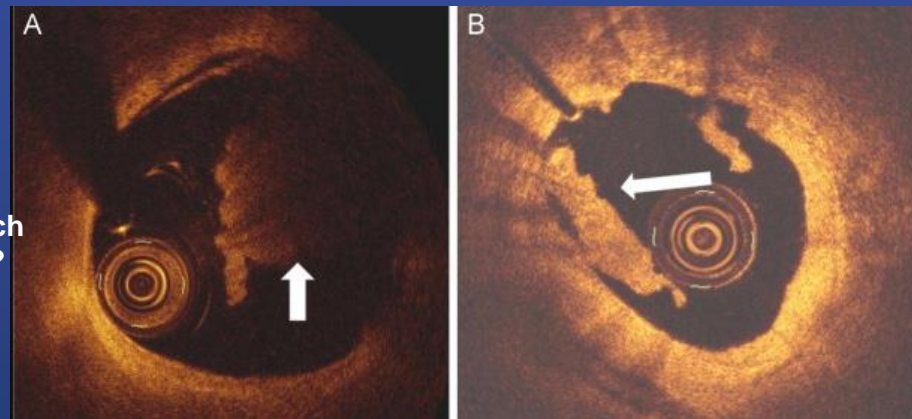


Cath. Lab takes time to arrive

Thrombus		
Acute	Subacute	Organized
n=3 (3.3%, 0.7-9.3)	n=91 (100.0%, 96.0-100.0)	n=20 (22.0%, 14.0-31.9)



Acute th. : Fresh thrombus, Platelet rich
RBC-rich? Platelet rich in histology?
Be dyed blood

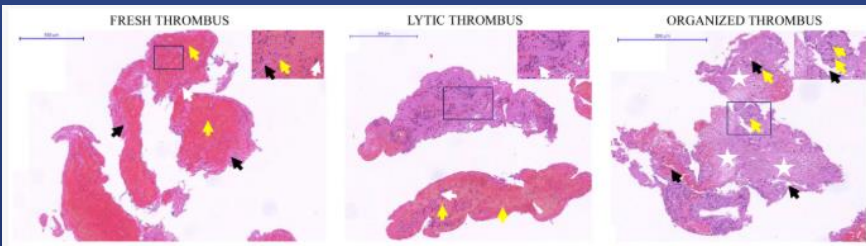


Pattern Red thrombus in OCT

Medium Backscattering, High Attenuation

Pattern White thrombus in OCT

Medium Backscattering, Low Attenuation

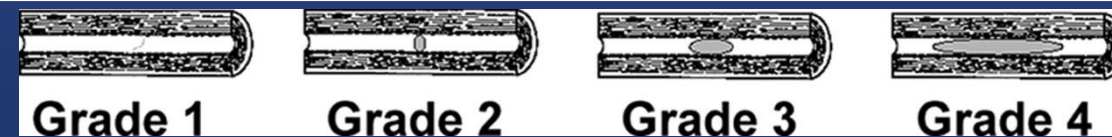


Fresh : intact cellular element and layered structure
Lytic : colliquation, karyorrhexis of granulocytes
Organized : internal growth of smooth muscle cells, connective tissue deposition, and proliferation, recanalization

Archives of Cardiovascular Diseases Volume 105, Issue 10, October 2012, Pages 529-534
Optical coherence tomography: From physical principles to clinical applications
Tomographie par cohérence optique : des principes physiques aux applications cliniques



TIMI thrombus burden classification	Description
TIMI thrombus Grade 0	No angiographic evidence of thrombus
TIMI thrombus Grade 1	Angiographic features suggestive of thrombus <ul style="list-style-type: none"> • decreased contrast density • haziness of contrast • irregular lesion contour • a smooth convex meniscus at the site of a total occlusion • suggestive, but not firmly diagnostic of thrombus
TIMI thrombus Grade 2	Definite thrombus presents in multiple angiographic projections <ul style="list-style-type: none"> • marked irregular lesion contour with a significant filling defect • greatest dimension is $<1/2$ vessel diameter
TIMI thrombus Grade 3	Definite thrombus appears in multiple angiographic views <ul style="list-style-type: none"> • greatest dimension from $>1/2$ to 2 vessel diameters
TIMI thrombus Grade 4	Definite large thrombus present <ul style="list-style-type: none"> • Greatest dimension >2 vessel diameters
TIMI thrombus Grade 5	Thrombotic total occlusion <ul style="list-style-type: none"> • a convex margin that stains with contrast, persisting for several cardiac cycles



Large thrombus burden vs. Small thrombus burden

Included in the analysis n=806
Complete 10-year-follow-up n=797(MAX. 15 year)

TABLE 2. Angiographic and procedural characteristics.

Characteristics	Total (n = 806)	Small Thrombus Burden (n = 580)	Large Thrombus Burden (n = 226)	P-Value
MI presentation				
Infarct duration (hours)	4.7 ± 11.2	4.19 ± 8.4	4.93 ± 14.9	.61
Peak CK-MB (IU/L)	312.7 ± 301.6	303.5 ± 289.9	334.3 ± 327.5	.32
Primary PCI	725 (90.0%)	515 (88.8%)	210 (92.9%)	.80
Rescue PCI	81 (10.0%)	65 (11.2%)	16 (7.1%)	.80
Cardiogenic shock	77 (9.6%)	51 (8.8%)	26 (11.5%)	.24
Stent thrombosis	22 (2.7%)	6 (1.0%)	16 (7.1%)	<.001
Multivessel disease	313 (38.8%)	232 (40.0%)	81 (35.8%)	.28
Infarct-related artery				
Left main stem	12 (1.5%)	11 (1.9%)	1 (0.4%)	.20
Left anterior descending	410 (50.9%)	304 (52.4%)	106 (46.9%)	.18
Right coronary artery	300 (37.2%)	202 (34.8%)	98 (43.4%)	.03
Circumflex coronary artery	79 (9.8%)	62 (10.7%)	17 (7.5%)	.19
Vein or IMA graft	5 (0.6%)	4 (0.2%)	1 (1.8%)	>.99
Multivessel PCI	86 (10.7%)	70 (12.1%)	16 (7.1%)	.04
Inotropes	92 (11.4%)	61 (10.5%)	31 (13.7%)	.20
Glycoprotein IIb/IIIa inhibitors	406 (50.4%)	255 (44.0%)	151 (66.8%)	<.001
Bifurcation stenting	52 (6.5%)	34 (5.9%)	18 (8.0%)	.28
Direct stenting	450 (55.8%)	329 (56.7%)	121 (53.5%)	.41
Thrombectomy	63 (7.8%)	4 (0.7%)	59 (26.2%)	<.001
TIMI flow at baseline				
0	464 (57.6%)	313 (54.0%)	151 (66.8%)	<.01
1	124 (15.4%)	79 (13.6%)	45 (19.9%)	.03
2	112 (13.9%)	93 (16.0%)	19 (8.4%)	<.01
3	106 (13.2%)	95 (16.4%)	11 (4.9%)	<.001
Final TIMI flow grade 3	738 (91.8%)	550 (94.8%)	188 (83.6%)	<.001
No-reflow	12 (1.5%)	3 (0.5%)	9 (4.0%)	<.01
Distal embolization	59 (7.3%)	20 (3.4%)	39 (17.3%)	<.001

Data presented as mean ± standard deviation or number (%). CK = creatine kinase; IMA = internal mammary artery; MI = myocardial infarction; PCI = percutaneous coronary intervention; TIMI = Thrombolysis in Myocardial Infarction.

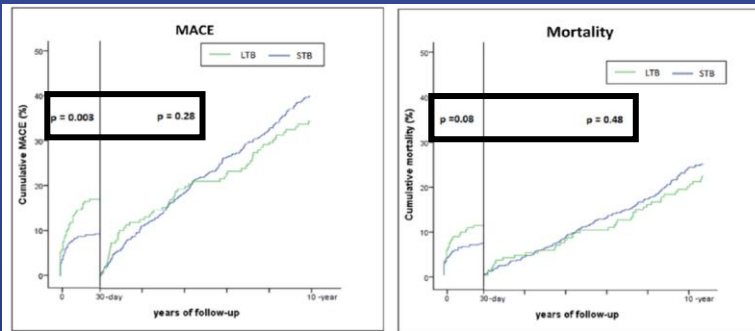


FIGURE 3. Landmark analysis on 30-day and post 30-day major adverse cardiovascular event (MACE) rate and mortality rate according to thrombus burden. LTB = large thrombus burden, STB = small thrombus burden. Landmark analysis demonstrates a significantly higher MACE rate in patients with LTB during the first 30 days ($P < .01$). Thereafter, cumulative MACE was comparable between patients with LTB and STB ($P = .28$). Landmark survival analysis shows a trend of higher mortality rate in the LTB group ($P = .08$) in the first 30 days; after 30 days, there was no difference between the 2 groups ($P = .48$). Kaplan-Meier estimates, log-rank test.



Impact of thrombus burden on long-term clinical outcomes in patients with either anterior or non-anterior ST-segment elevation myocardial infarction

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Abstract

Large thrombus burden (LTB) during ST-segment elevation myocardial infarction (STEMI) could translate into worse clinical outcomes. The impact of a LTB in terms of long-term clinical outcomes on different myocardial infarct territories has not yet been fully evaluated. From April 2002 to December 2004, consecutive patients with STEMI undergoing percutaneous coronary intervention with drug eluting stent were evaluated. The study sample was stratified in two groups: anterior STEMI and non-anterior STEMI. LTB was considered as a thrombus larger than or equal to 2-vessel diameters, and small thrombus burden less than 2-vessel diameters. Major adverse cardiac events (MACE) were evaluated at 10-year and survival data were collected up to 15-year. A total of 812 patients were evaluated, 6 patients were excluded due to inadequate angiographic images, 410 (50.9%) had an anterior STEMI and 396 (49.1%) a non-anterior STEMI. Patients with LTB had higher rates of 10-year mortality (aHR 2.27, 95%CI 1.42–3.63; $p = 0.001$) and 10-year MACE (aHR 1.46, 95%CI 1.03–2.08; $p = 0.033$) in anterior STEMI, but not in non-anterior STEMI (aHR 0.78, 95%CI 0.49–1.24; $p = 0.298$; aHR 0.71, 95%CI 0.50–1.02; $p = 0.062$). LTB was associated with increased 30-day mortality (aHR 5.60, 95%CI 2.49–12.61; $p < 0.001$) and 30-day MACE (aHR 2.72, 95%CI 1.45–5.08; $p = 0.002$) in anterior STEMI, but not in non-anterior STEMI (aHR 0.39, 95%CI 0.15–1.06; $p = 0.066$; aHR 0.67, 95%CI 0.31–1.46; $p = 0.316$). Beyond 30-day, LTB had no impact on mortality and MACE in both groups. In anterior STEMI, LTB is associated with worse long-term clinical outcomes, this effect was driven by early events.

Keywords ST-segment elevation myocardial infarction · Myocardial infarction · Anterior infarction · Thrombus burden · Percutaneous coronary intervention · Mortality

Highlights

- Large thrombus burden has a significant impact on mortality and MACE at 10 years in patients with anterior STEMI, but not in patients with non anterior STEMI.
- The impact of thrombus burden is mainly driven by early events.

- The reclassification of the thrombus burden after wire crossing in the occluded infarct related artery (G5) was applicable in almost every lesion, 99% of the cases.
- More than two thirds of the thrombotic occlusions, initially evaluated as large thrombus burden were actually caused by small thrombus.
- The reclassification of G5 might improve quantitative thrombus estimation.

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Introduction

Primary percutaneous coronary intervention (PCI) represents the gold standard therapy for coronary revascularization during ST-segment elevation myocardial infarction (STEMI) and a timely reperfusion strongly correlates with clinical outcomes [1]. However, despite the restoration of



- Reclassification of G5 through MIMI (Minimal Invasive Mechanical Intervention) differences in MACE became evident between the groups (anterior LTB vs STB) (before : Ant. LTB - 10y mortality Δ / after : Ant. LTB - 10y mortality, MACE Δ)
- G5 : reflects only the state of the flow rather than the real amount of the thrombus
- Reclassification of G5 : More than two thirds (67.5%) of the thrombotic occlusions (G5), initially evaluated as large thrombus burden were actually caused by small thrombus) [LTB G4 n=78(9.6%), G5 n=456(56%) -> LTB G4 n=226(28%), STB G0~3 n=580(72%)]

What problem dose thrombus-rich lead to ?

- Increased incidence of stent thrombosis
- Final TIMI flow grade3 achievement rate is relatively low
- Thrombus dissolution after PCI ?
Evagination, Late-malapposition
- Stent expansion during PCI ?
Fully expansion : increase thrombus protrusion and No-reflow/Slow flow
Under expansion : Late-malapposition due to thrombus dissolution
- No-reflow/Slow-flow and microvascular obstruction due to distal embolism

PCI strategy for minimizing No-reflow, Slow flow and mitigating MVO ?

Figure 2. Potential Advantage and Pitfalls of a Deferred Stenting Strategy Compared to Immediate Stenting in Patients with High Thrombus Burden

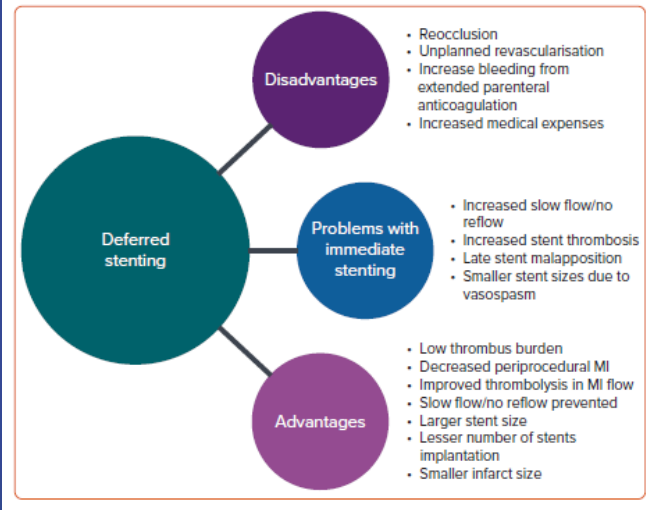
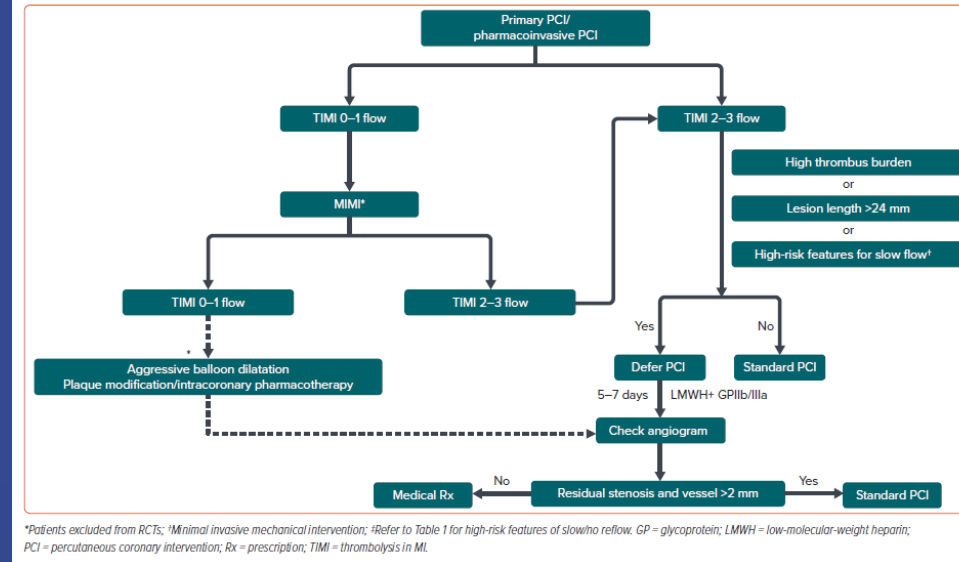


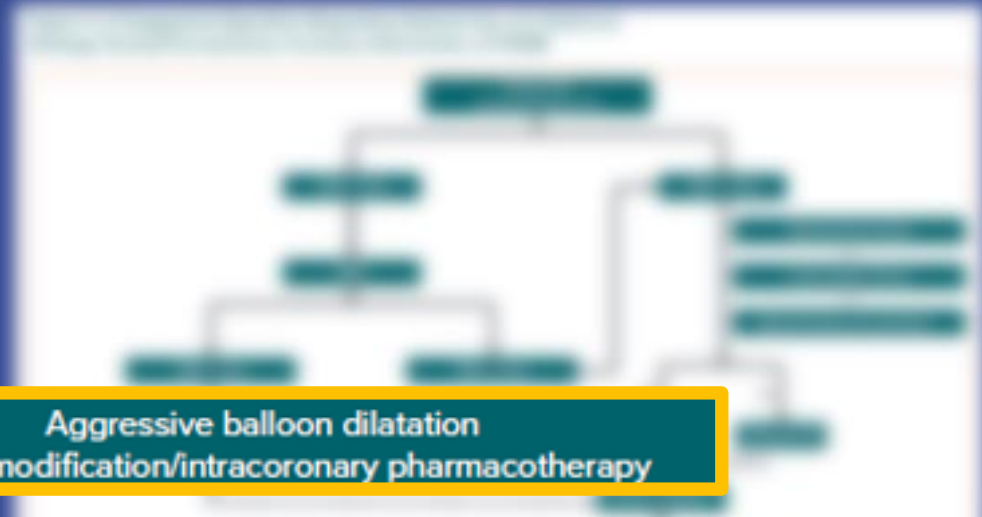
Figure 4. A Suggested Algorithm Regarding Optimal Use of a Deferred Strategy During Percutaneous Coronary Intervention of STEMI



5 RCTs (DEFER STEMI, MIMI, DANAMI-3, INNOVATION, PRIMACY) + meta-analysis

- Heavy thrombus burden is not uncommon during PCI for STEMI and is an important contributor to the slow-flow /no-reflow phenomenon
- Deferred stenting aims to lower thrombus burden and improve TIMI flow during the deferment time with the help of anticoagulants
- Multiple studies and meta-analyses have shown benefits in terms of reduced slow flow/no reflow, improvement in ejection fraction and decreased MACE in some
- A routine deferred strategy has not been shown to be beneficial and is definitely not advisable. But cases with high thrombus burden, longer lesions, high-risk features for slow flow and those with suboptimal TIMI flow (0-1) after thrombus aspiration can be candidates for deferred stenting
- The ideal window for deferral is a matter of debate but longer deferral periods up to 5-7 days have proven to be safe and are advocated

PCI strategy for minimizing No-reflow, Slow flow and mitigating MVO ?



Aggressive balloon dilatation
Plaque modification/intracoronary pharmacotherapy

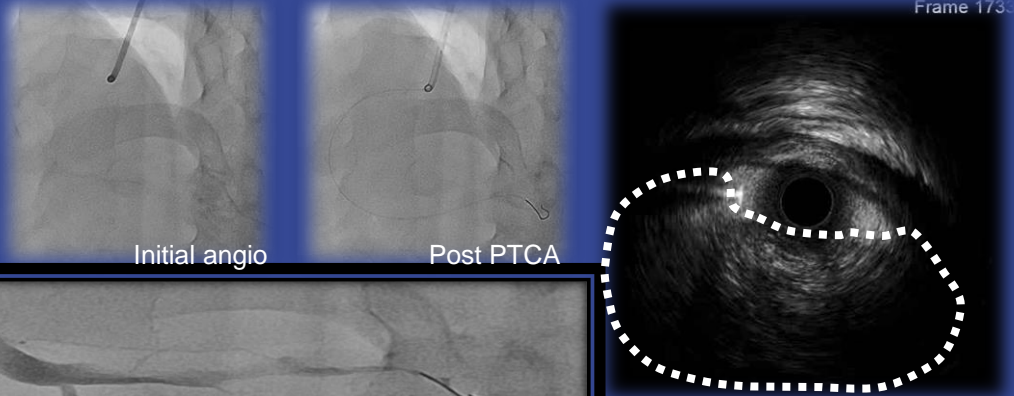
FOR DEFERRED PCI IMPLEMENTATION, TIMI 3 FLOW MUST BE SECURED !!
Why did you mention that you are a candidate for deferred stenting despite being suboptimal after aspiration?

- In some cases, optimal TIMI flow is not secured even after MIMI -> more intensive intervention is required
- Rarely, TIMI flow 3 is impossible even in aggressive balloon dilatation/intracoronary pharmacotherapy
- In this scenario, deferred PCI is not tested in RCT, but in this case stenting is also questionable
- In this case, an individualized approach is needed

suboptimal TIMI flow (0–1) after thrombus aspiration

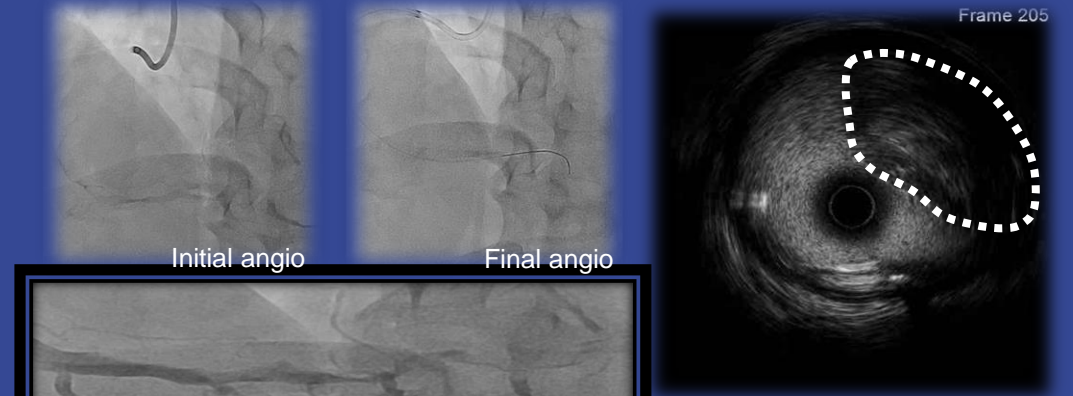
PRIMARY REPERFUSION SECONDARY STENTING(DEFERRED STENTING)

PRIMARY REPERFUSION

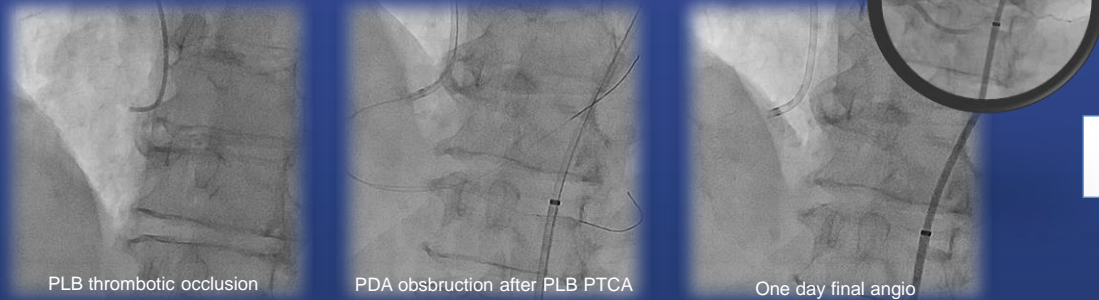


2days later

SECONDARY STENTING

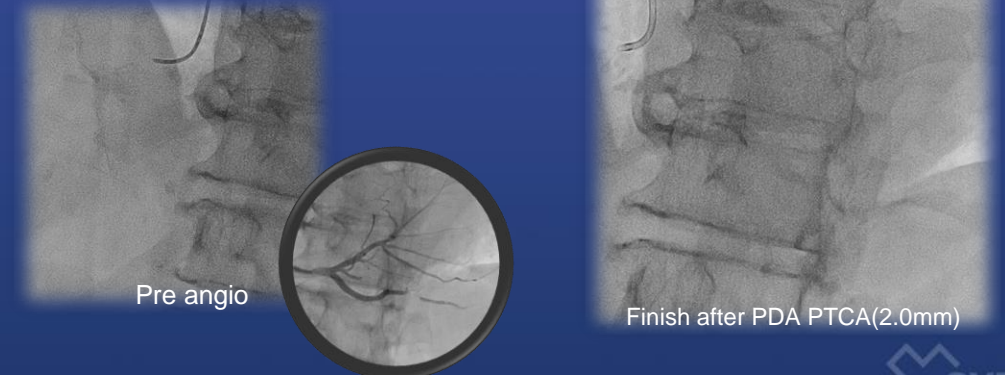


PRIMARY REPERFUSION



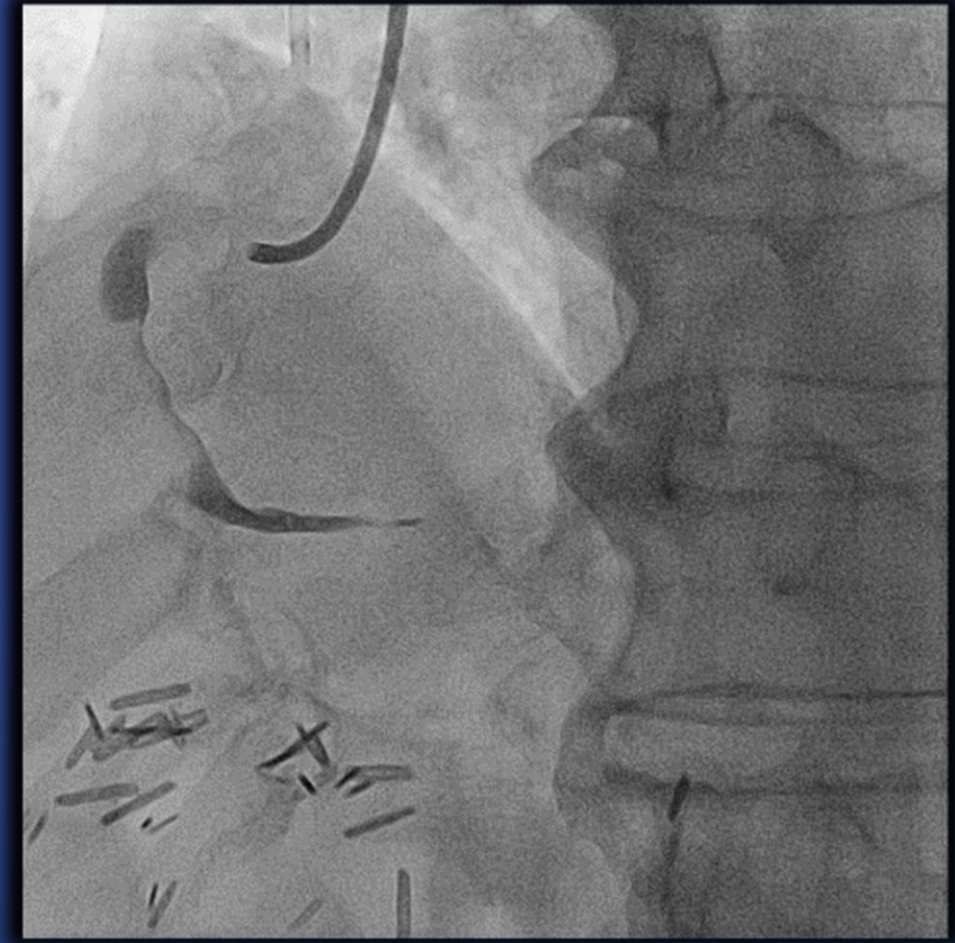
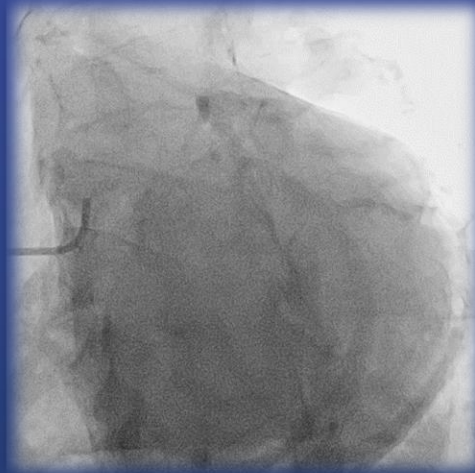
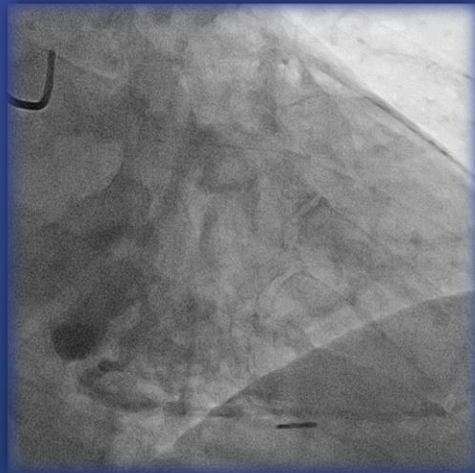
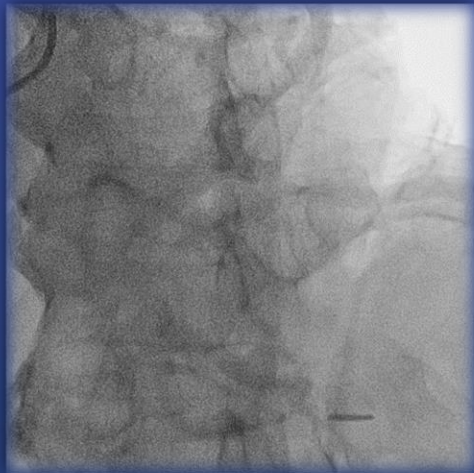
Next day

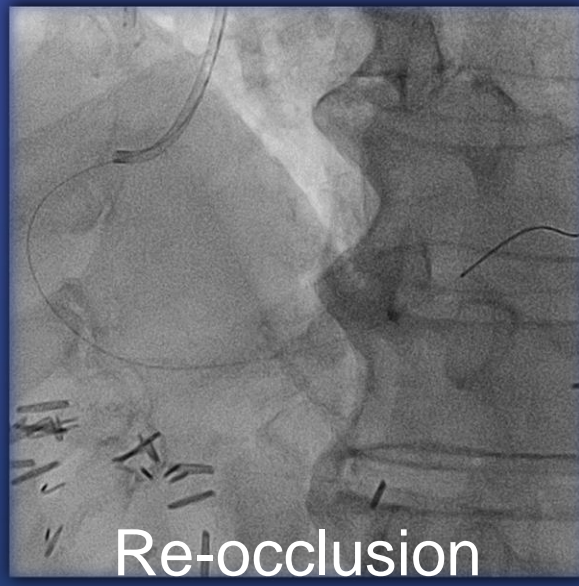
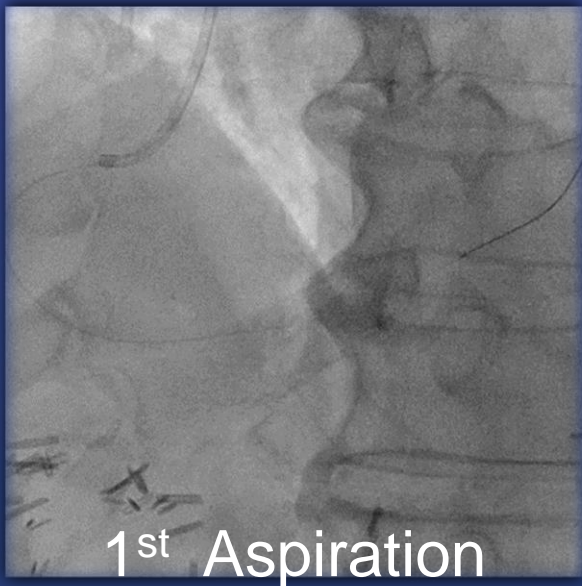
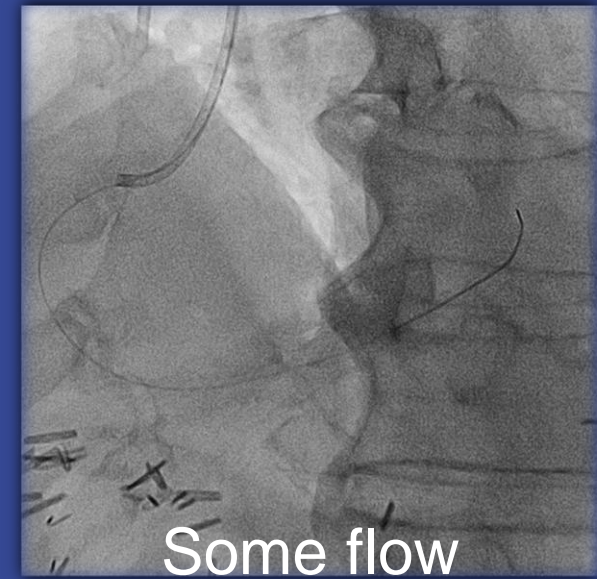
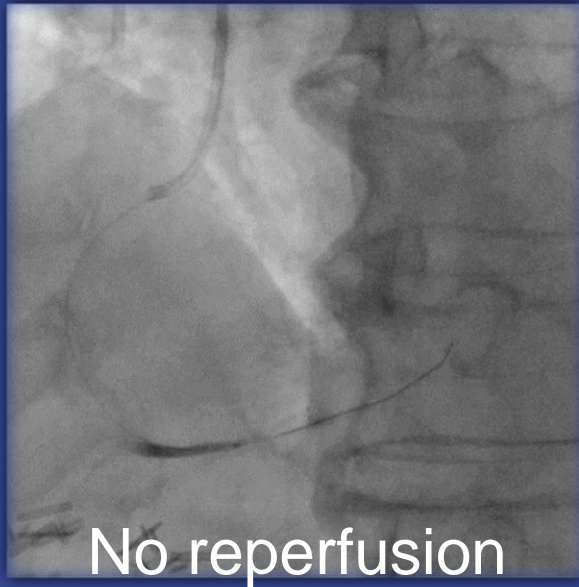
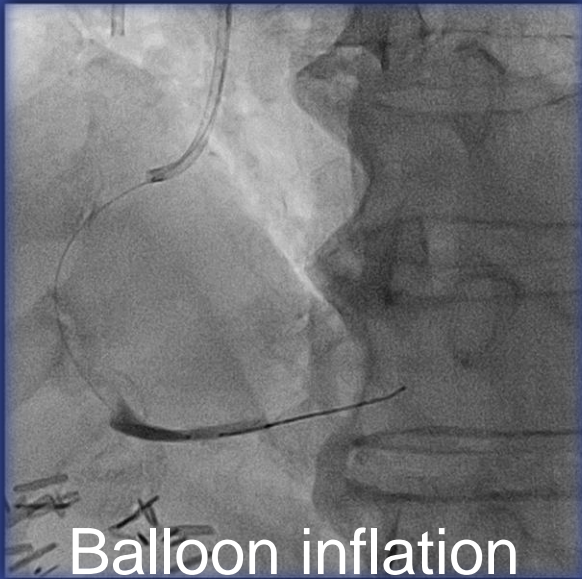
DOES NOT STENTING



CASE review

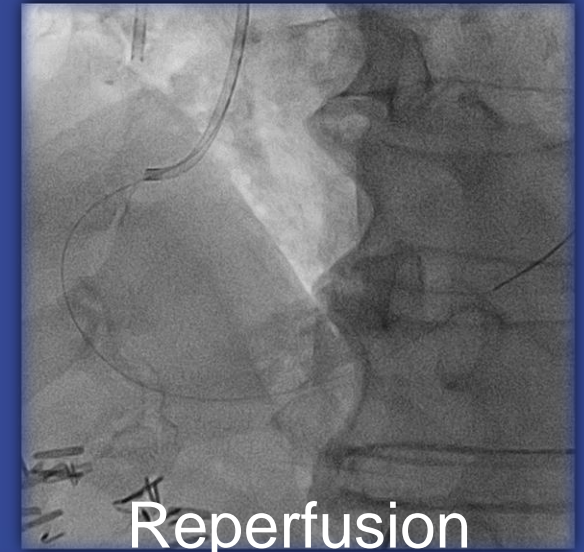
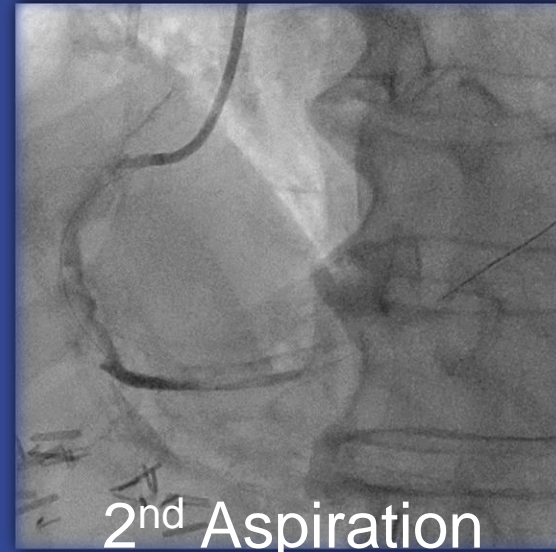
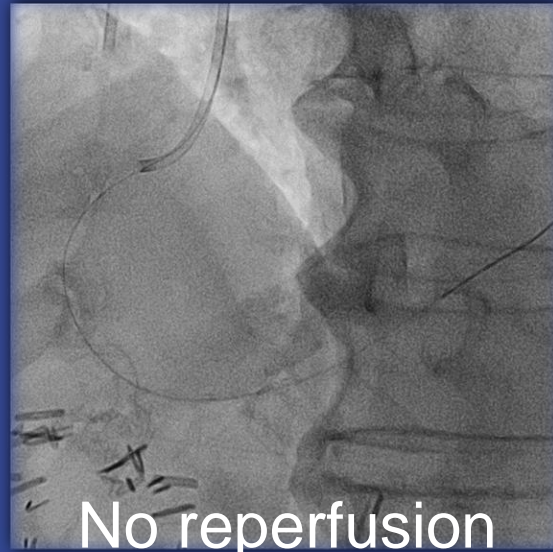
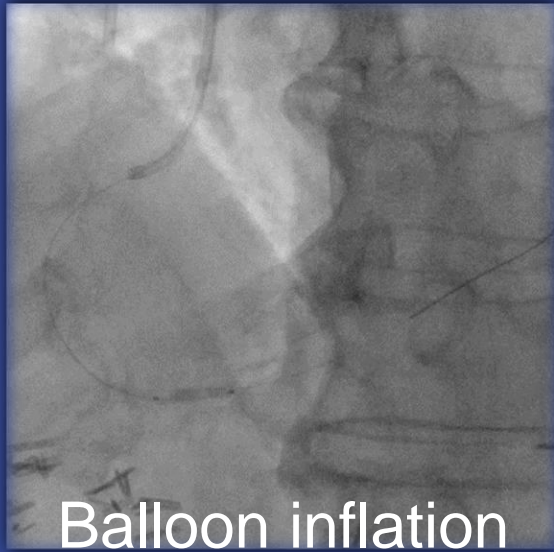
Fall backward on the way to
bathroom complaining of chest pain





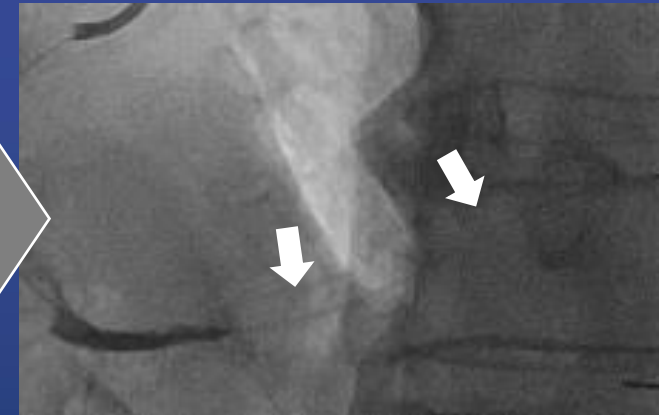
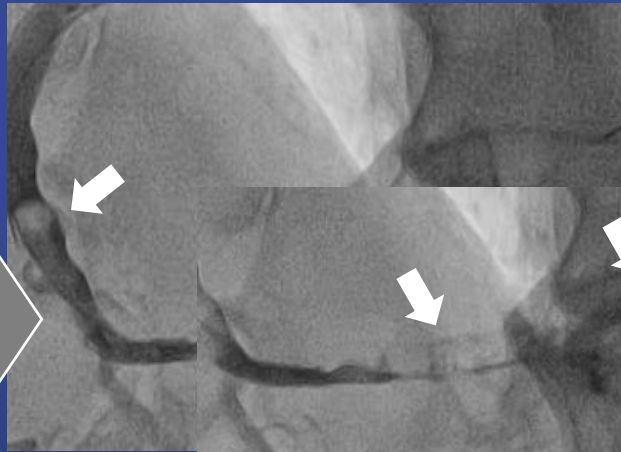
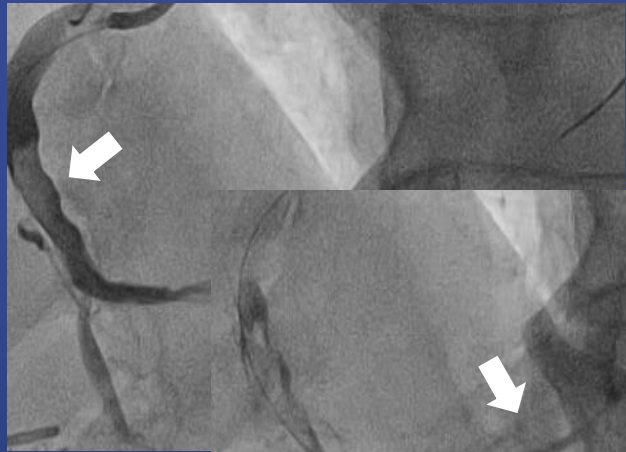
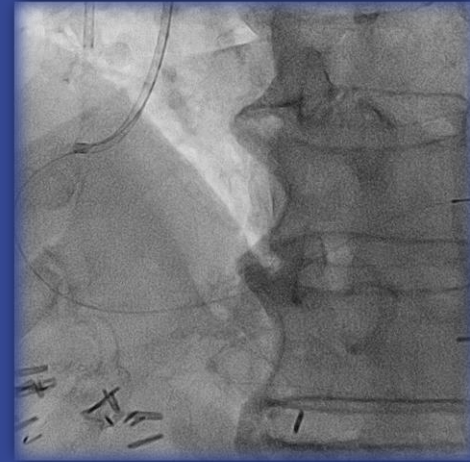
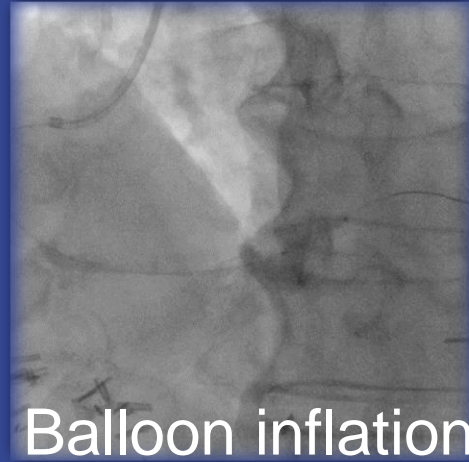
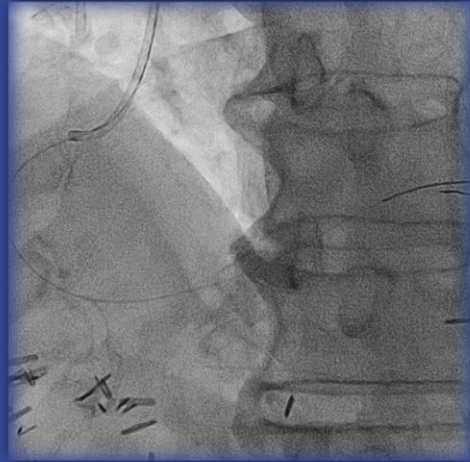
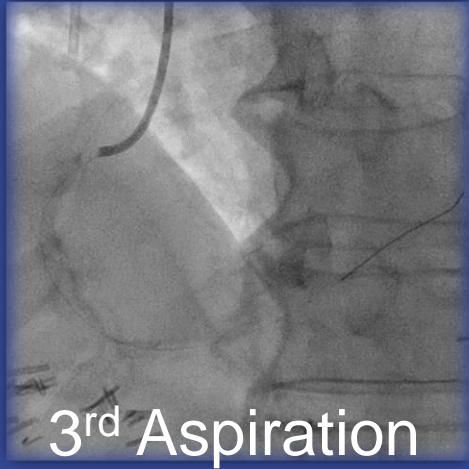
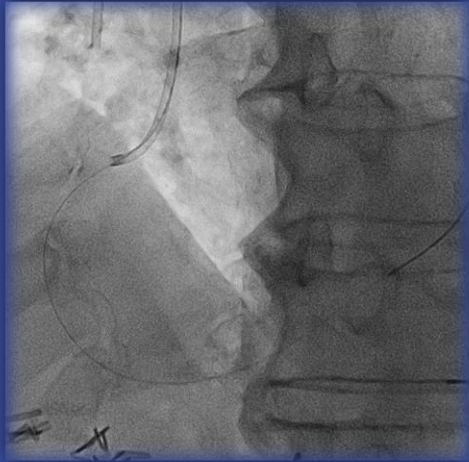
- Abciximab IC ?
Ear bleeding...
Hemorrhage from occipital impact ?
Possibility of brain hemorrhage...
- Suspected brain hemorrhage ?
On-site stent insertion ?
Consider staged PCI after primary reperfusion !

First of all, somehow.....reperfusion of coronary flow !



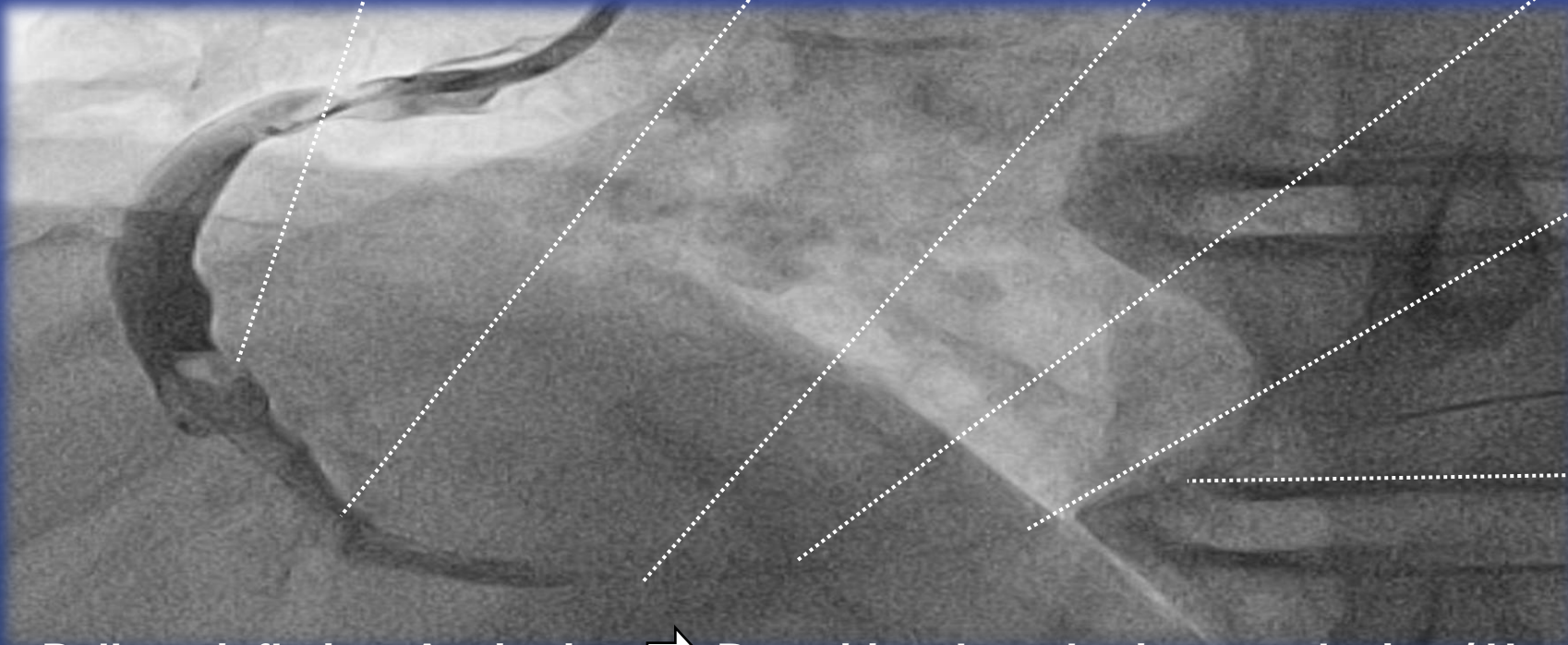
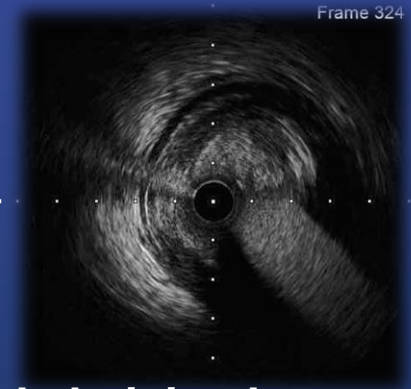
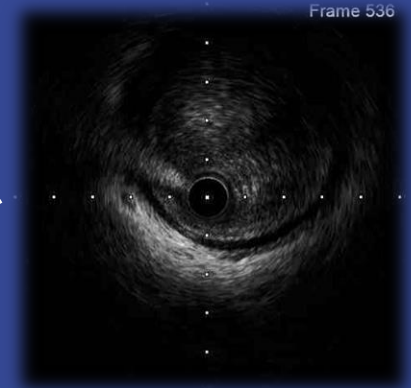
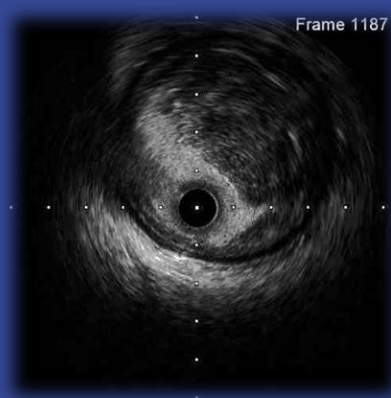
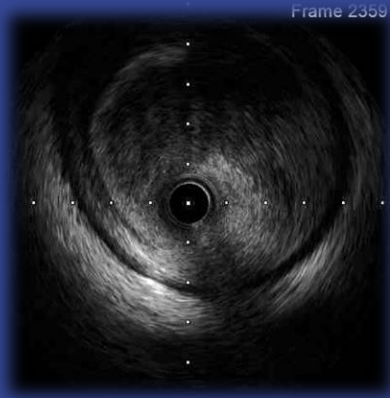
Finally succeeded in coronary reperfusion !
Determined to implement 2nd staged PCI !

Re-occlusion...



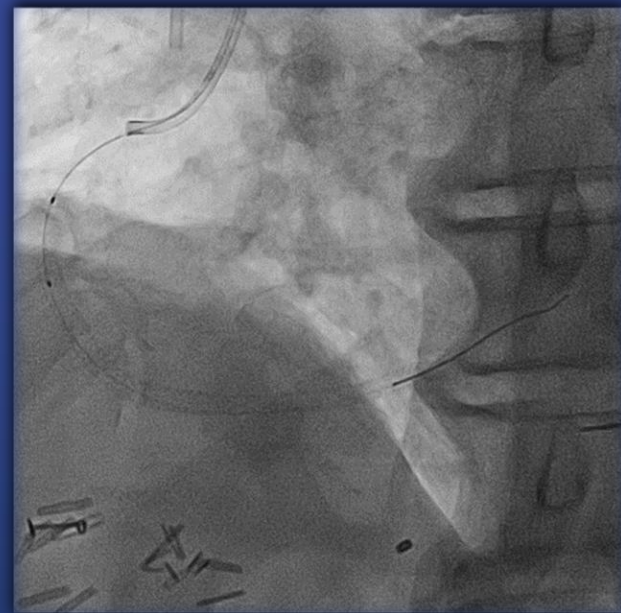
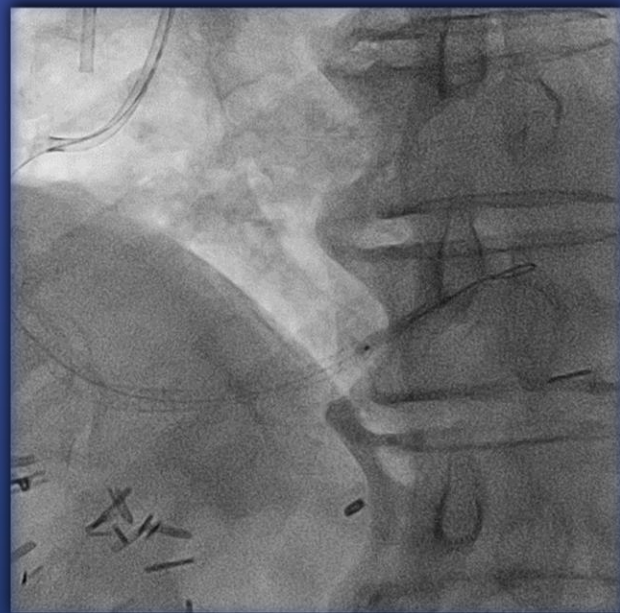
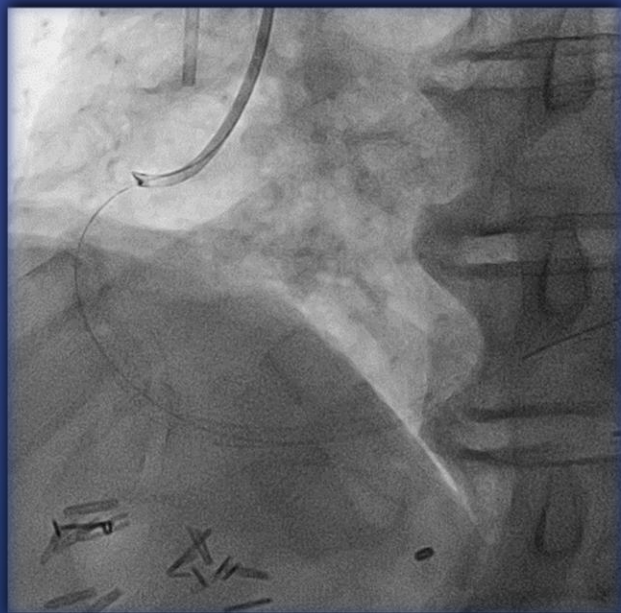
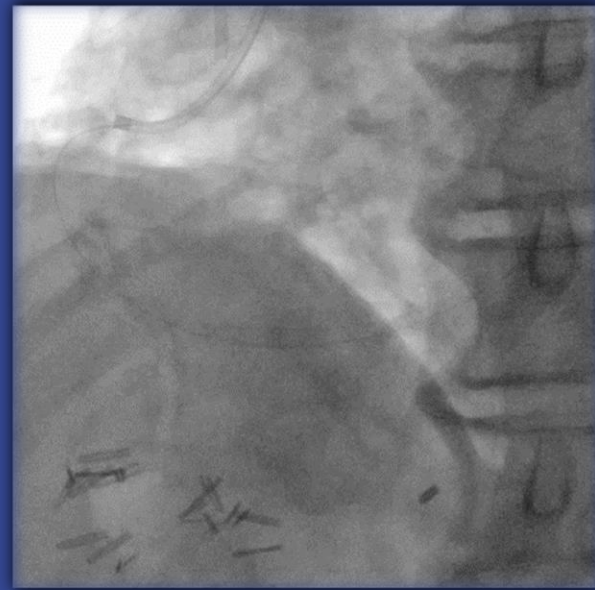
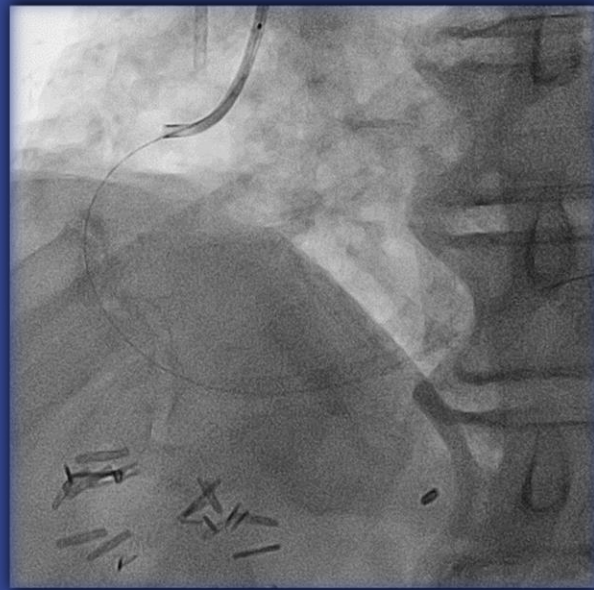
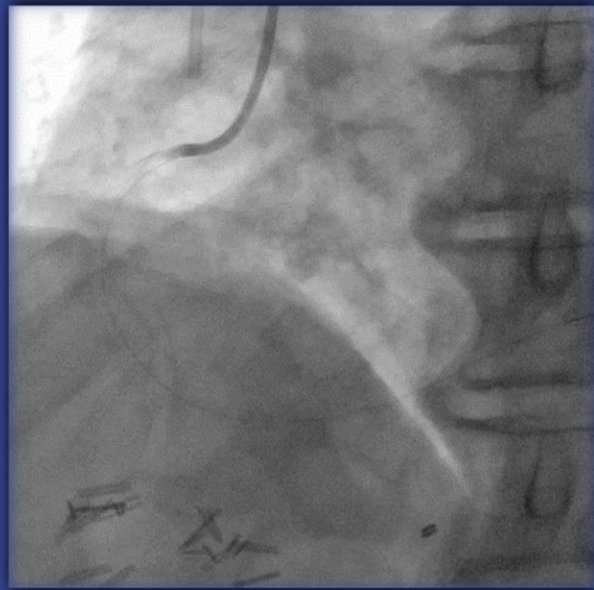
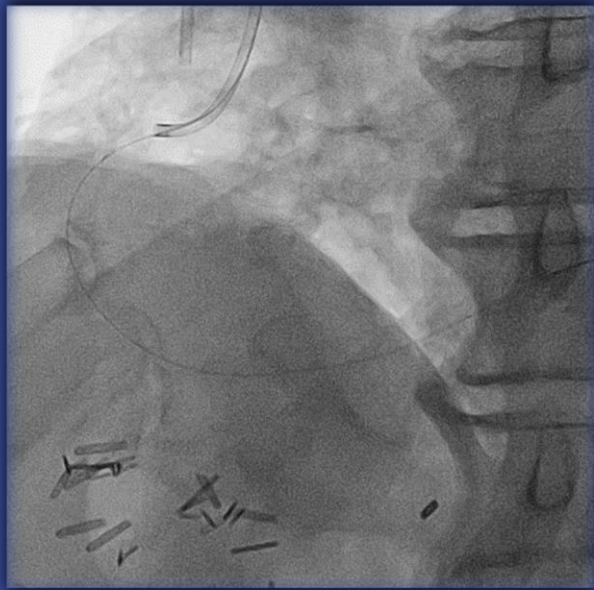
mRCA thrombus pattern and dRCA lumen contour : effective thrombectomy
Re-occlusion after ballooning

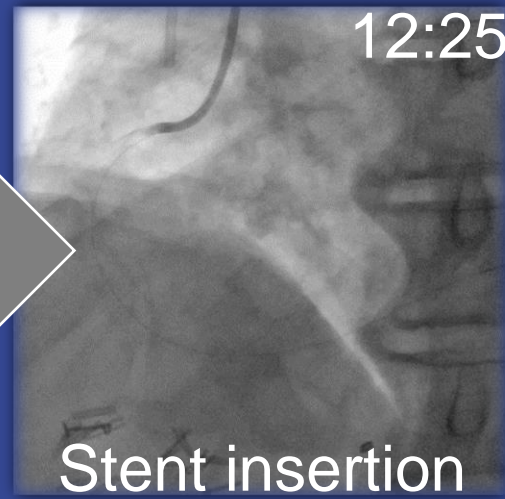
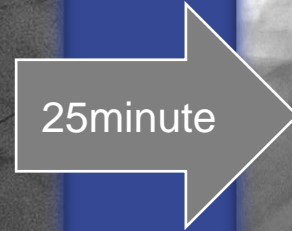
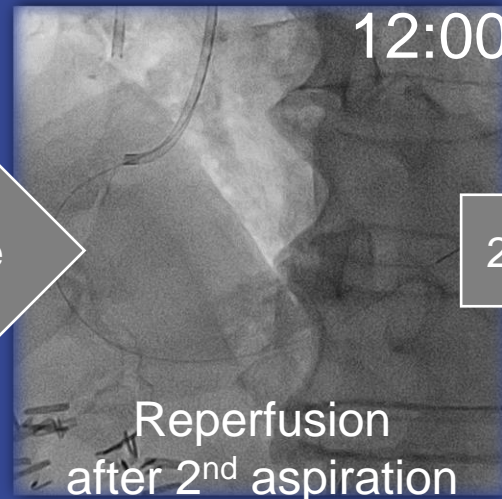
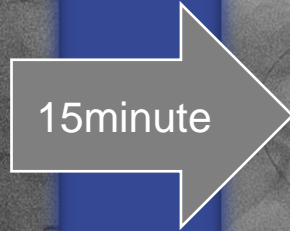
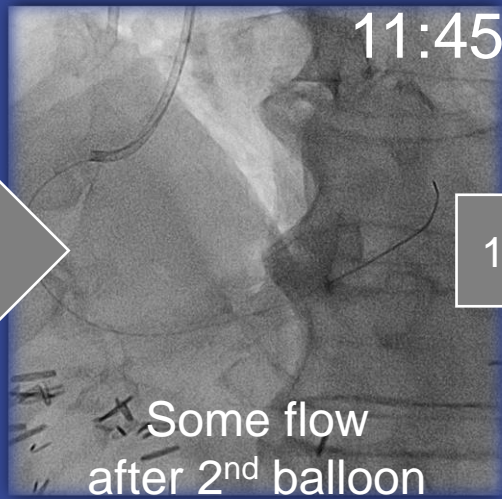
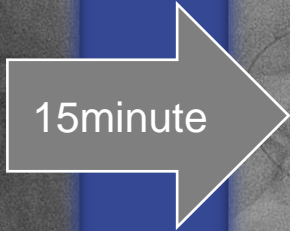
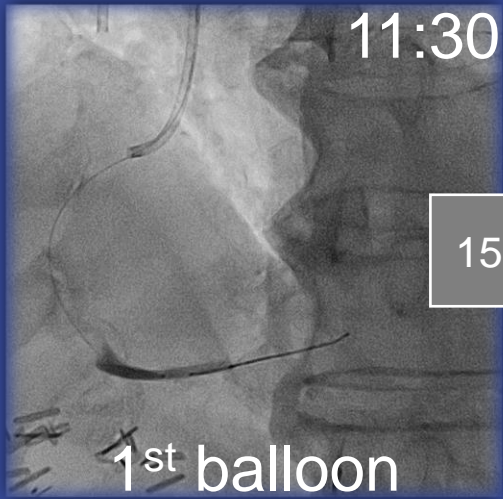
IVUS



Balloon inflation, Aspiration → Repetitive thrombotic re-occlusion / Use of restricted abciximab

No reflow due to LTB concerns : Stent under-expansion

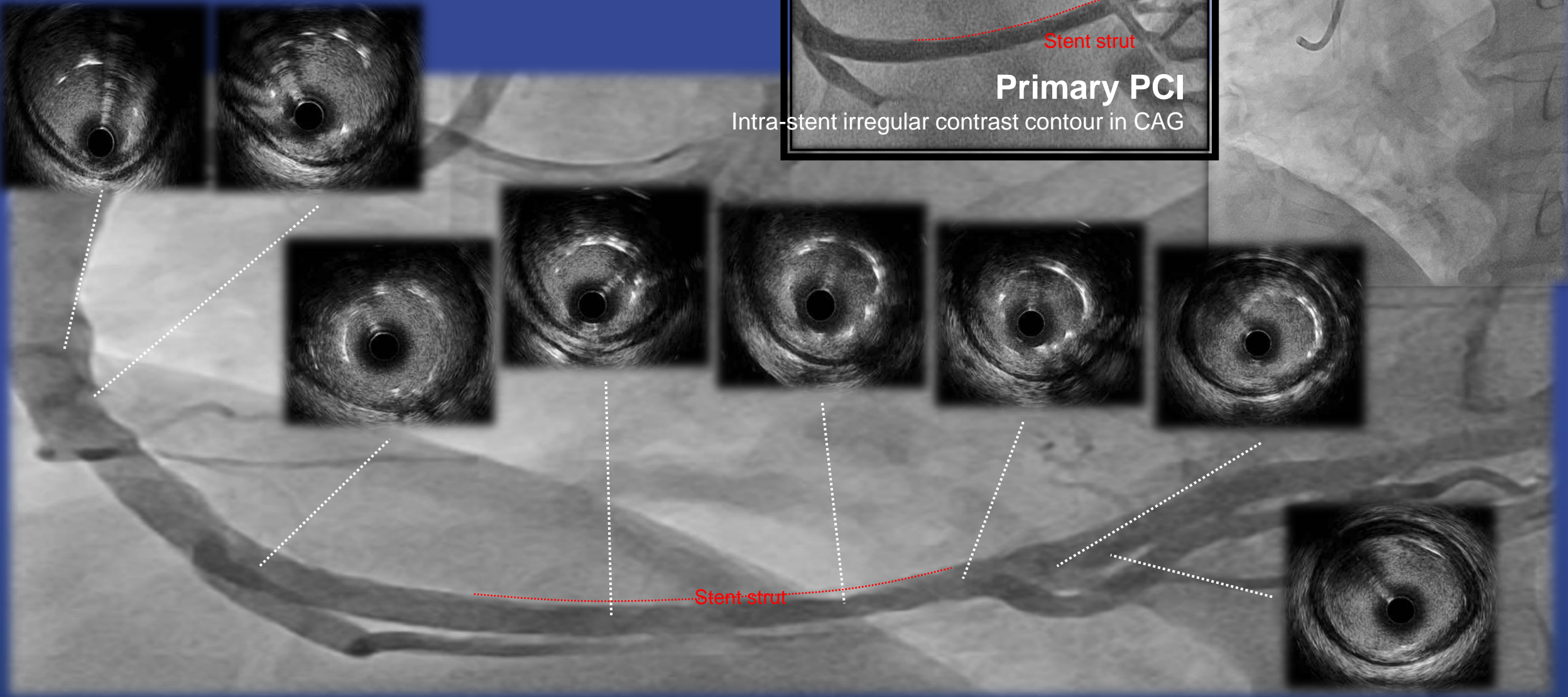
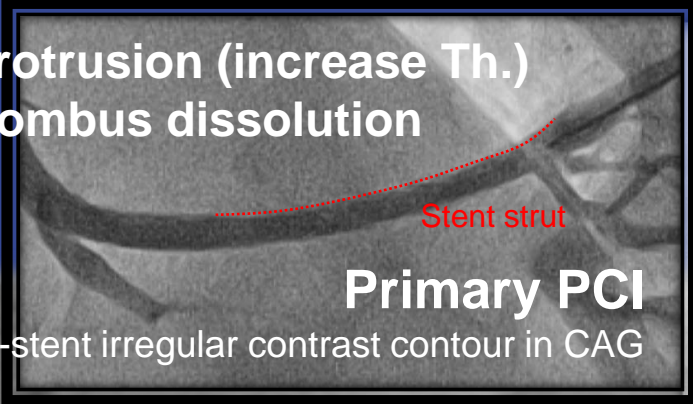




Really tried hard for 55 minutes for
Primary reperfusion secondary stenting

1 week later

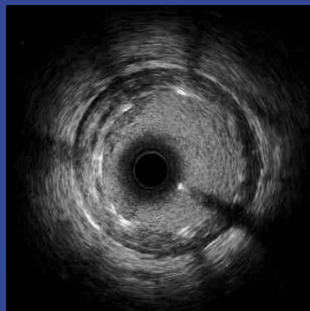
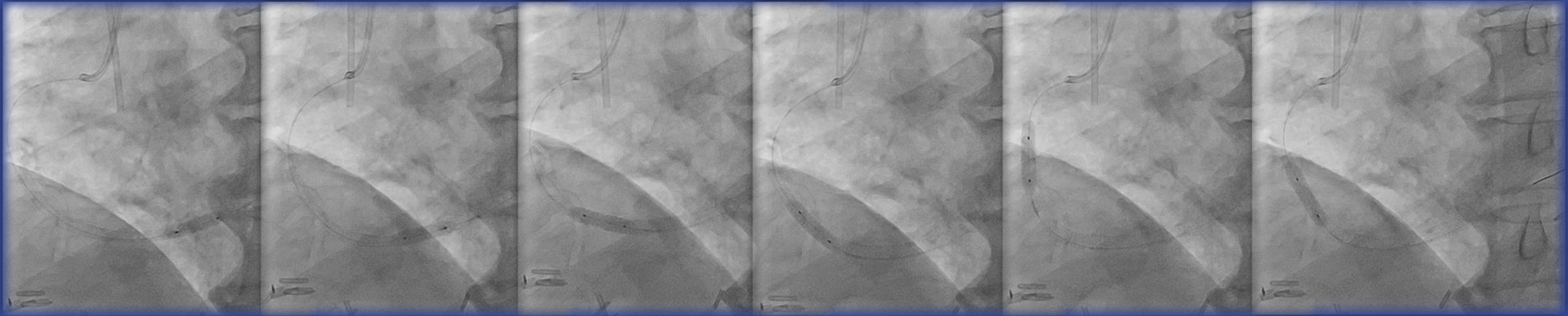
Thrombus formation due to protrusion (increase Th.)
Late malapposition due to thrombus dissolution



1 week later : Brain hemorrhage not worsening

F/U with medical treatment vs. Additional intervention(adjunctive balloon)

- Follow up with medical treatment ?
 - Worried about too many LTB
 - Until when medical treatment without additional intervention ?
 - When is adjunctive balloon ? or not implement adjunctive balloon ?
 - Additional intervention after hemorrhage was completely cured ?
 - Concerns of stent thrombosis due to acute/late malapposition that may occur while waiting for a cure
- Additional intervention ?
 - Hemorrhage just didn't get worse.....
 - Use heparin and DAPT for additional procedures(bleeding risk accordingly)
 - Thrombotic events(no-reflow etc.) that may occur during the procedure
 - event occur : abciximab injection ?
 - What if additional procedures exacerbate brain hemorrhage ?



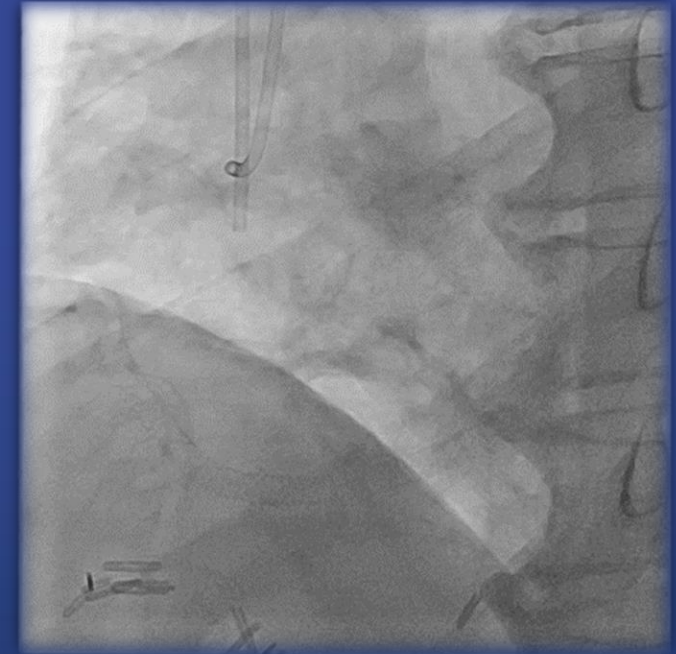
D. edge



In-Stent (good apposition and protrusion, Positive remodeling)



P. Edge (malapposition < 1mm)

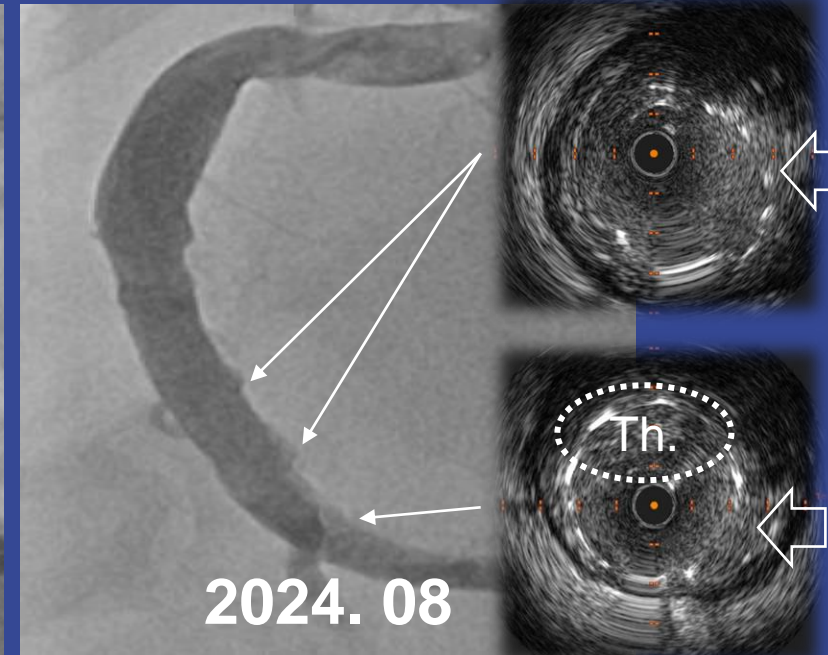
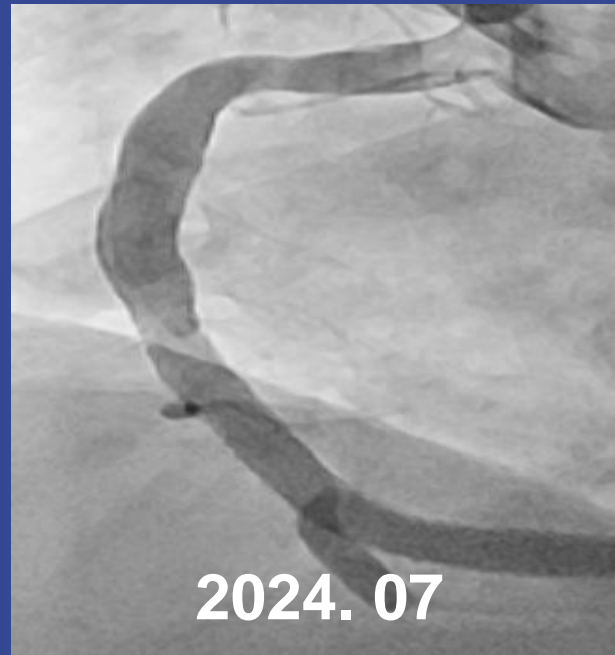
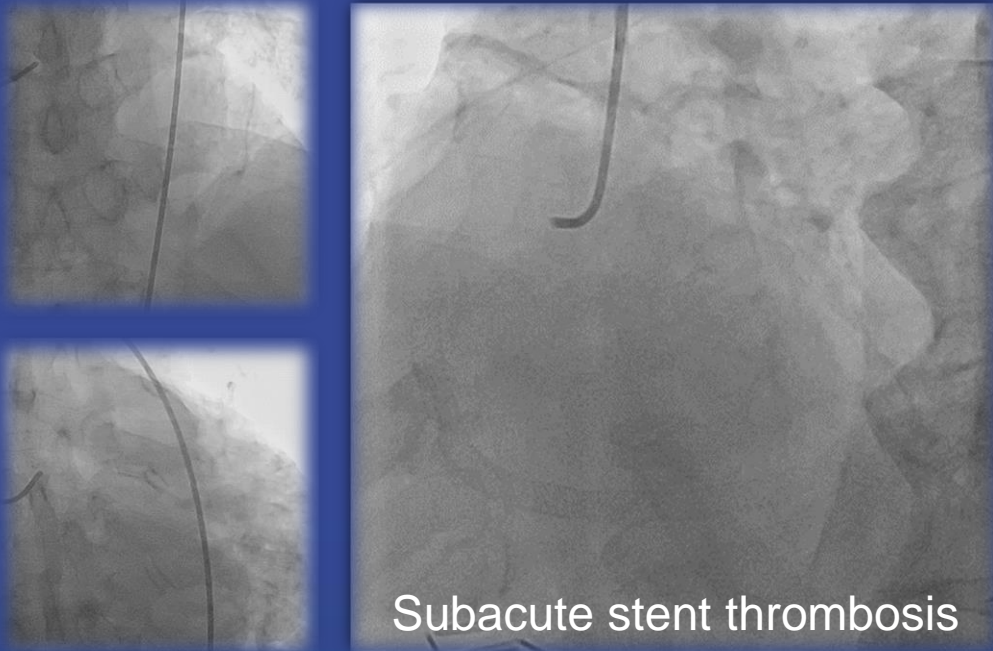


Clopidogrel single → DAPT

What if you expand it even more ? major tissue protrusion and no reflow ?

Ensuring sufficient lumen area

1 month later Cardiac enzyme F/U

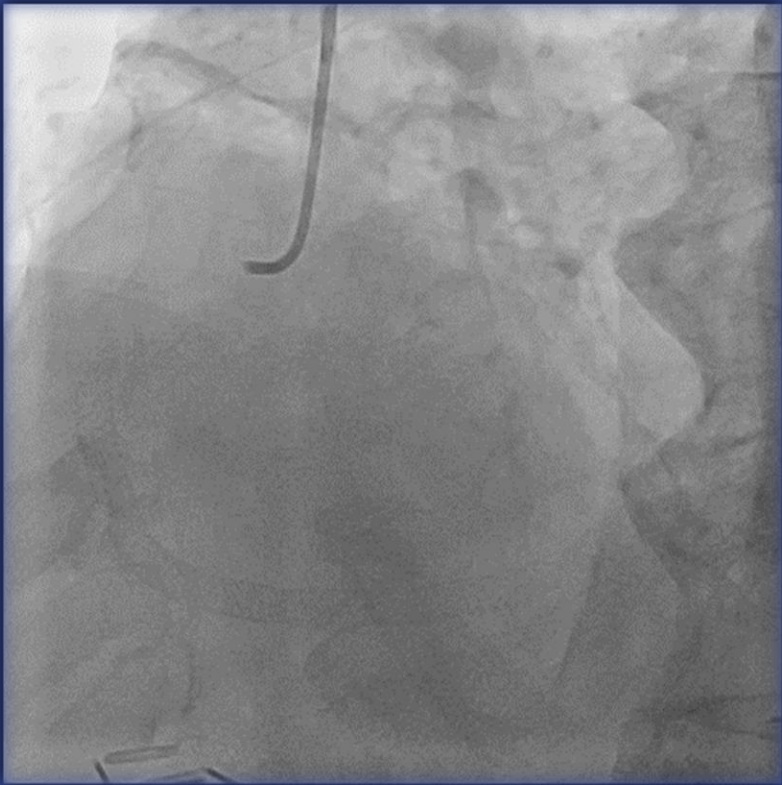


- Irregular lumen contour
- Contrast filling in sub-stent

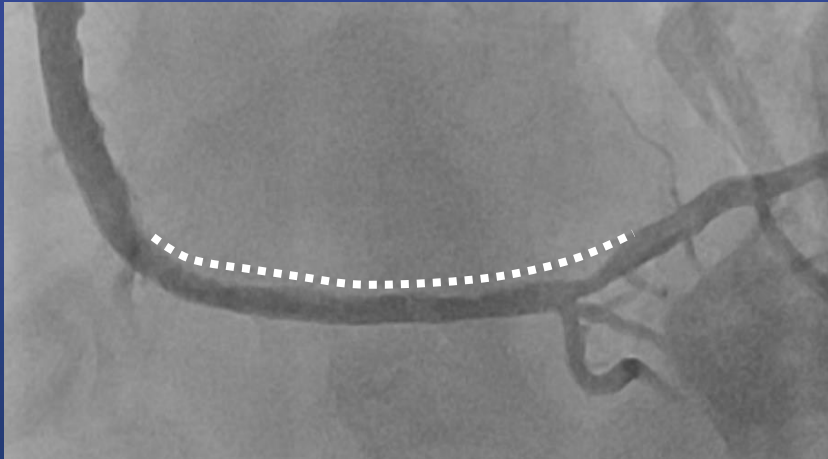
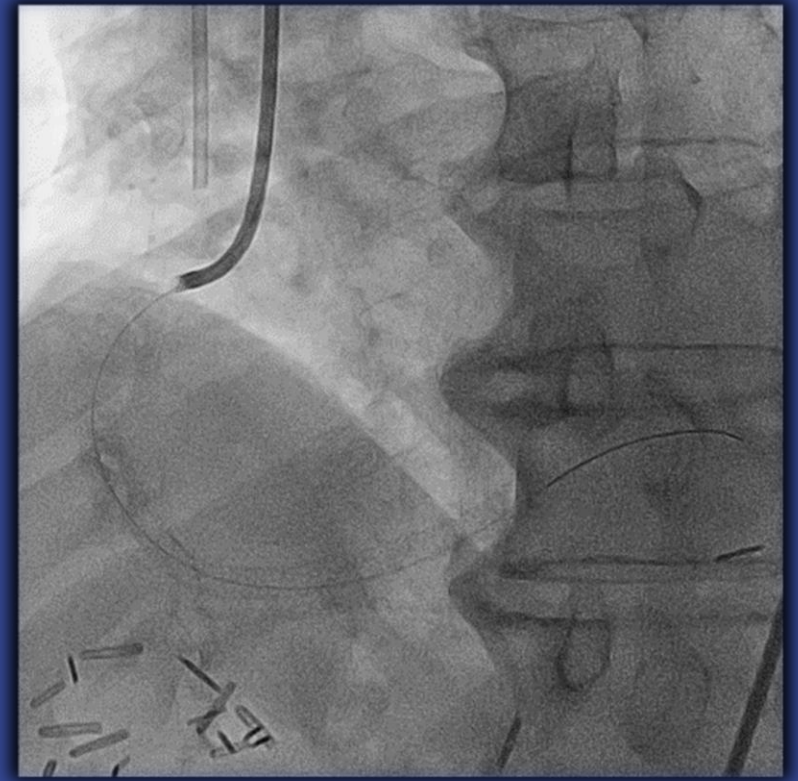
Late malapposition
due to thrombus dissolution

- CBD cancer, klatskin tumor : Thrombogenic Tendency
- + Late malapposition / Protrusion → Thrombus formation ?

Follow Up after thrombus dissolution



3 days



Discussion

Best option may be primary reperfusion deferred stent

But if it doesn't go your way

- Primary PCI with Post dilatation ?
- On-site PCI and 2nd staged adjunctive balloon after thrombus dissolution ?
- First of all, observation while using anticoagulants after PCI ?

Conclusion

➤ Stent expansion in LTB lesion : Under expansion vs. Fully expansion

➤ Sequential intervention is good choice in LTB lesion and Benefits for

- Minimize
 - Slow flow/No-reflow
 - Microvascular obstruction
 - Late-malapposition
 - Major thrombus protrusion
- Decrease stent number / Stent size as large as possible

A nighttime photograph of a city skyline. The central focus is a tall, modern skyscraper with many windows glowing with yellow light. To its right, another building is visible with some red and white lights. In the foreground, there's a lower building with a red facade and glass windows, also illuminated. The sky is a deep blue, suggesting dusk or dawn. The overall scene is a vibrant urban landscape.

**Thank you for
your attention**