

IVUS-Guided vs. Angiography-Guided CTO-PCI

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Conflict of interest

- I, Gerald S. Werner, MD, have received speaker fees from
 - Abbott Vascular
 - ASAHI Intecc
 - Daichi Sankyo
 - Orbus-Neich
 - Philips-Volcano
 - Siemens
 - Terumo



The Essential Role of IVUS in CTO-PCI

- IVUS in the antegrade approach
 - Identify the proximal cap
 - Verify true lumen entry
 - Try to guide reentry into true lumen
 - Verify true lumen position after reentry
- IVUS in the retrograde approach
 - Identify issues with hampered retrograde wire
 - IVUS guided reverse CART
 - **Mandatory when approaching left main**
- IVUS to optimize stenting in diffusely diseased CTOs
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Registries in complex PCI indicate IVUS benefit

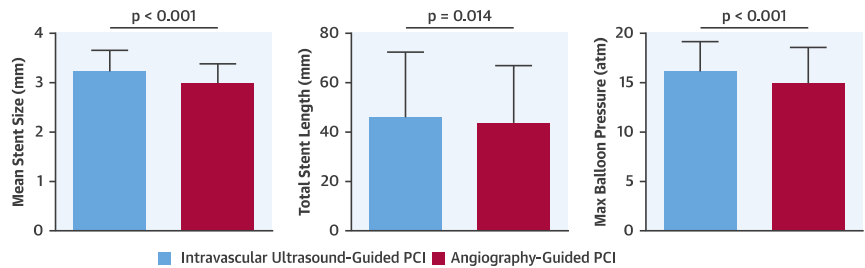


Impact of Intravascular Ultrasound-Guided Percutaneous Coronary Intervention on Long-Term Clinical Outcomes in Patients Undergoing Complex Procedures

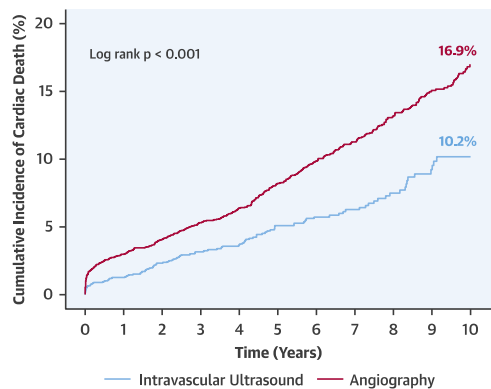
Ki Hong Choi, MD,^a Young Bin Song, MD, PhD,^a Joo Myung Lee, MD, MPH, PhD,^a Sang Yoon Lee, MD,^a Taek Kyu Park, MD, PhD,^a Jeong Hoon Yang, MD, PhD,^{a,b} Jin-Ho Choi, MD, PhD,^{a,c} Seung-Hyuk Choi, MD, PhD,^a Hyeon-Cheol Gwon, MD, PhD,^a Joo-Yong Hahn, MD, PhD^a



Procedural Factors



Clinical Outcomes



All Lesion	0.573 (0.460-0.714)
Bifurcation Lesion	0.682 (0.498-0.934)
Chronic Total Occlusion Lesion	0.670 (0.408-1.102)
Left Main Disease	0.203 (0.126-0.329)
Long Lesion	0.602 (0.450-0.804)
Multi-Vessel PCI	0.639 (0.473-0.864)
Multiple Stents Implantation	0.532 (0.332-0.855)
In-Stent Restenosis Lesion	0.837 (0.403-1.740)
Calcified Lesion	0.458 (0.052-4.012)

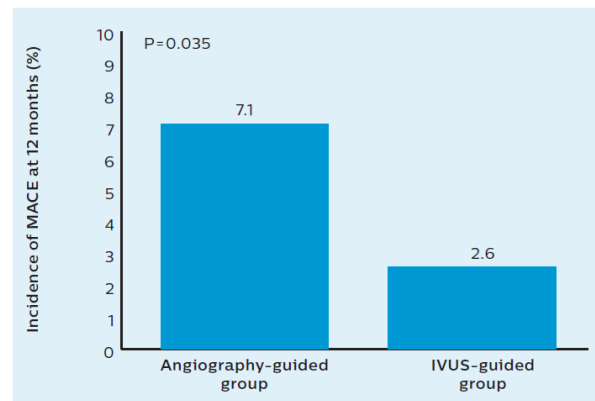
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Favors Intravascular Ultrasound | Favors Angiography



...but only weak clinical evidence for the use of IVUS in CTO





- 402 patients with CTOs were randomised (1:1):¹
 - To IVUS-guided or angiography-guided PCI
 - To Resolute zotarolimus-eluting or Nobori biolimus-eluting stents
- At 12 months, compared with angiography, IVUS patients :
 - Had significantly lower rates of MACE (2.6% vs 7.1%; hazard ratio 0.35; 95% CI [0.13–0.97]; P=0.035);
 - Were more likely to receive high-pressure dilatation after stenting with a higher maximum balloon pressure
 - Had larger MLD after stenting



Cumulative event rate analysis using the Kaplan–Meier method; IVUS-guided versus angiography-guided PCI of patients with CTO – a randomised study¹

Systematic Review

Clinical and Procedural Outcomes of IVUS-Guided vs. Angiography-Guided CTO-PCI: A Systematic Review and Meta-Analysis

Giuseppe Panuccio ^{1,2,*}, Youssef S. Abdelwahed ^{2,3} , Nicole Carabetta ¹, Nadia Salerno ⁴, David Manuel Leistner ^{5,6}, Ulf Landmesser ^{2,3,7}, Salvatore De Rosa ^{1,*} , Daniele Torella ⁴  and Gerald S. Werner ⁸ 

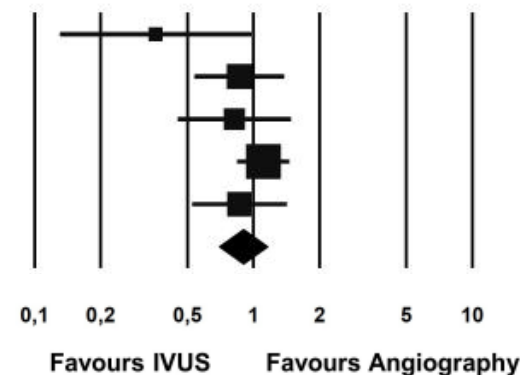
Study name

Statistics for each study

Events / Total

Risk ratio and 95% CI

	Risk ratio	Lower limit	Upper limit	Z-Value	p-Value	IVUS-guided	Angiography-guided
CTO-IVUS	0,357	0,131	0,973	-2,014	0,044	5 / 201	14 / 201
AIR-CTO	0,862	0,540	1,377	-0,621	0,534	25 / 115	29 / 115
K-CTO	0,818	0,453	1,478	-0,665	0,506	18 / 201	22 / 201
Progress-CTO	1,110	0,846	1,455	0,753	0,452	70 / 344	106 / 578
Kalogeropoulos et al	0,862	0,526	1,413	-0,589	0,556	25 / 182	29 / 182
Overall	0,899	0,699	1,156	-0,832	0,405	143/1043	200/1277





Differences in IVUS utilization around the globe



EuroIntervention

2024;20:e185-e197

published online e-edition February 2024

DOI: 10.4244/EIJ-D-23-00490

ORIGINAL RESEARCH

Contemporary outcomes of chronic total occlusion percutaneous coronary intervention in Europe: the ERCTO registry

Table 3. Procedural characteristics.

	Overall N=8,673	Antegrade N=6,282 (73)	Retrograde N=2,391 (27)	p-value
Technical success	7,727 (89.1)	5,832 (92.8)	1,895 (79.3)	<0.001
Intravascular lithotripsy	95 (1.1)	66 (1.1)	29 (1.2)	0.100

JACC: CARDIOVASCULAR IMAGING

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ORIGINAL RESEARCH

Effect of Coronary CTA on Chronic Total Occlusion Percutaneous Coronary Intervention



A Randomized Trial

TABLE 2 Procedural Characteristics and Immediate Procedural Outcomes

	Coronary CTA Guidance (n = 200)	Angiography Guidance (n = 200)	p Value
Use of intravascular ultrasound	118 (59)	105 (53)	0.191

Circulation: Cardiovascular Interventions

ORIGINAL ARTICLE

In-Hospital Outcomes of Chronic Total Occlusion Percutaneous Coronary Interventions in Patients With Prior Coronary Artery Bypass Graft Surgery

Insights From an International Multicenter Chronic Total Occlusion Registry

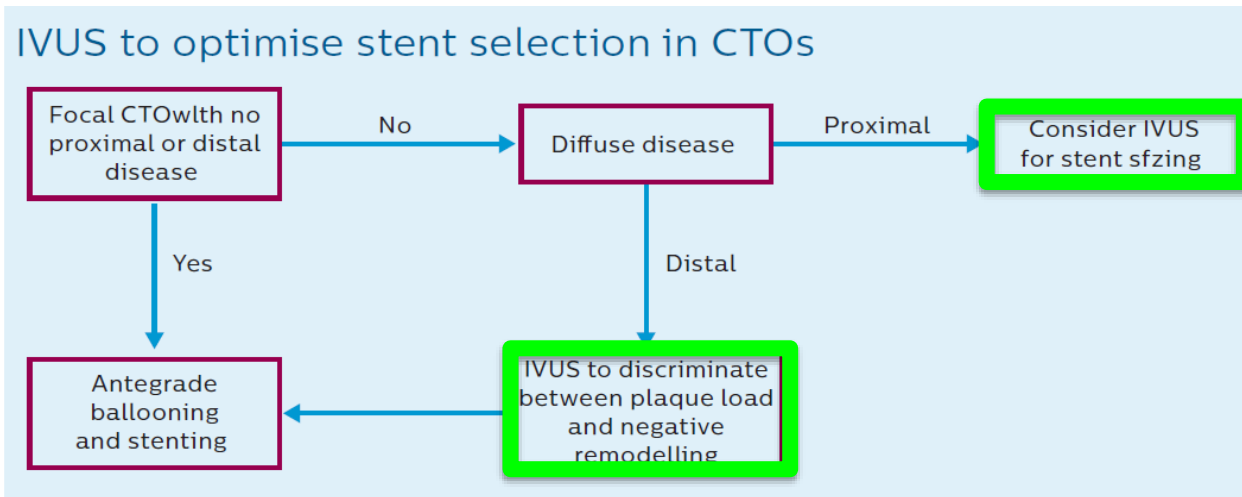
Table 3. Techniques Used for CTO PCI in the Study Patients

Variables	Overall (3486)	Prior Coronary Artery Bypass Graft Surgery		P Value
		Yes (n=1121)	No (n=2365)	
IVUS use	39.8%	42.7%	38.5%	0.052

- IVUS utilization varies around the globe
- Main reason in Europe for low use: lack of reimbursement
- My personal use: 70% in 2023



Practical use of IVUS in CTO interventions: IVUS to optimise stent selection in CTOs



- After opening a CTO, IVUS represents a useful tool to provide information about lesion length, morphology and identification of a landing zone for stent implantation
- After stenting, expansion, apposition and extension can be optimised with IVUS assessment



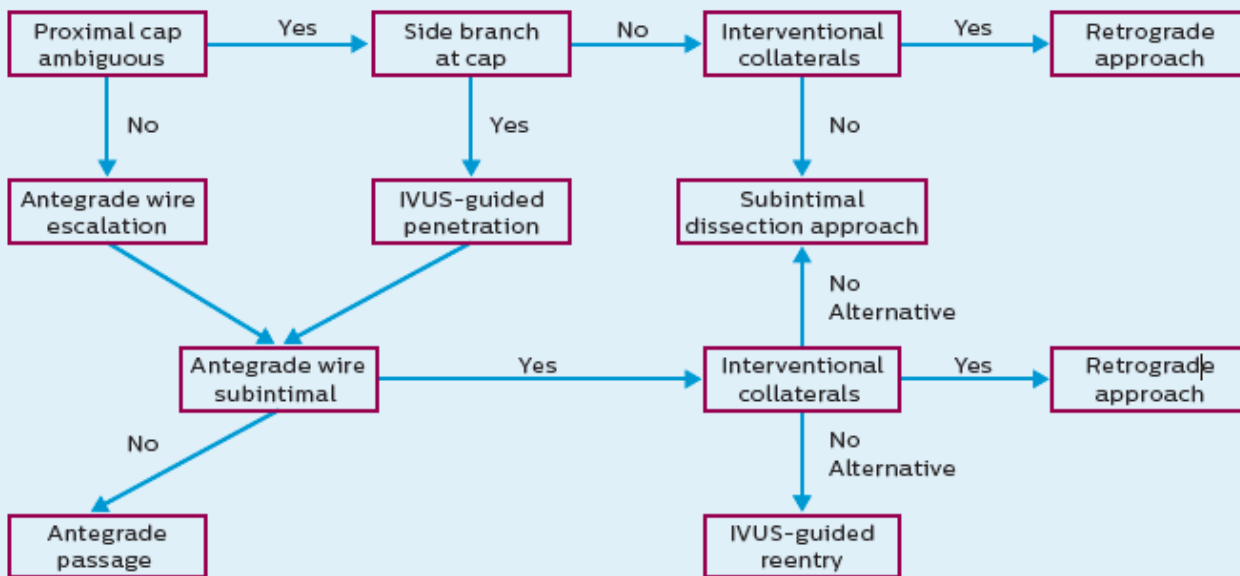
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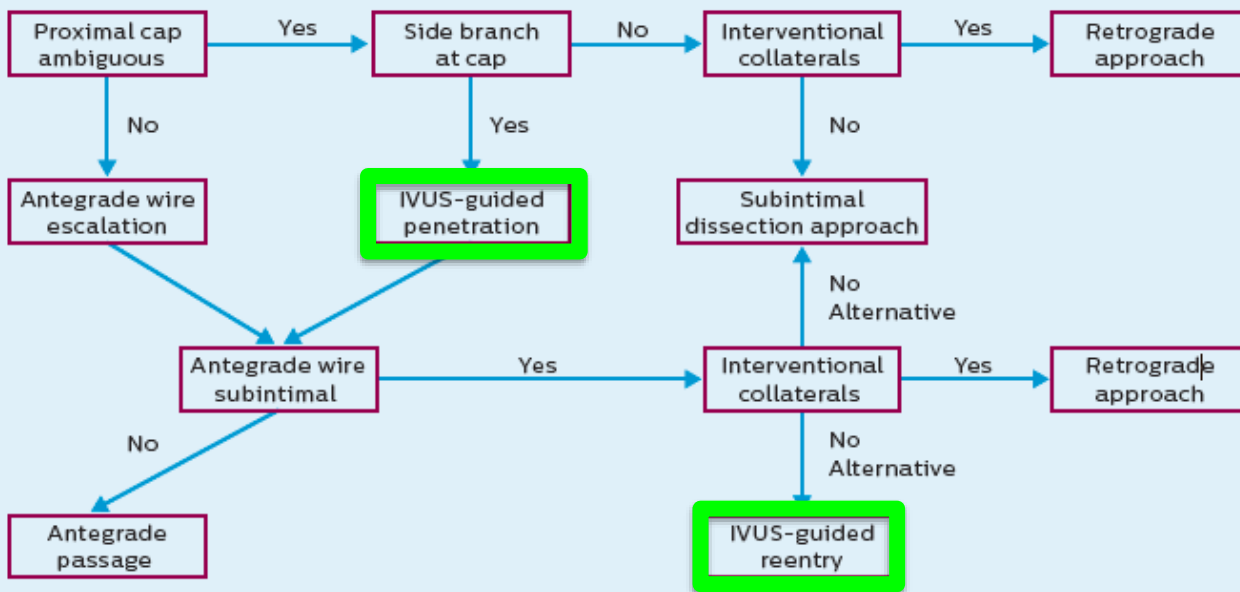
Practical use of IVUS in CTO interventions: IVUS in antegrade approach

How to perform IVUS in antegrade approach



Practical use of IVUS in CTO interventions: IVUS in antegrade approach

How to perform IVUS in antegrade approach





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From: Fundamental Wire Technique and Current Standard Strategy of Percutaneous Intervention for Chronic Total Occlusion With Histopathological Insights

J Am Coll Cardiol Interv. 2011;4(9):941-951. doi:10.1016/j.jcin.2011.06.011

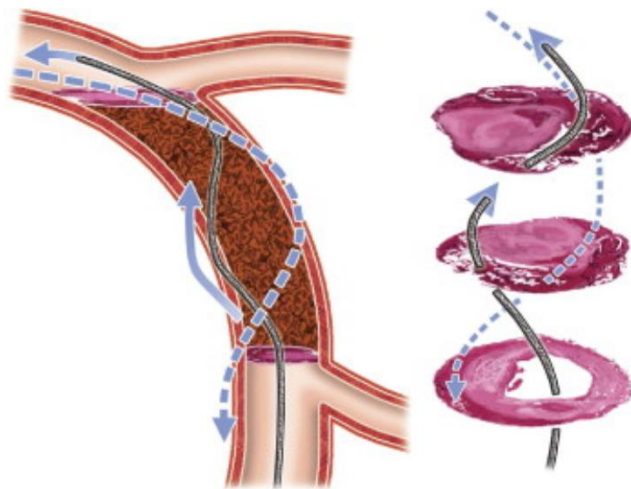


Figure Legend:

Principle of Retrograde Subintimal Tracking

Antegrade subintimal tracking (dotted line) and retrograde subintimal tracking (solid line). Even though the angiogram shows that the 2 wires are separated (antegrade and retrograde), both wires can be positioned in the same subintimal space. After the retrograde wire comes into the same lumen with the antegrade wire, crossing into the proximal true lumen with the retrograde wire is highly promising.

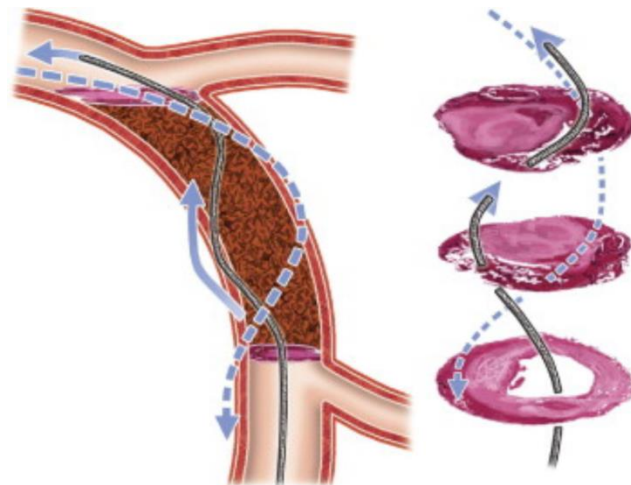
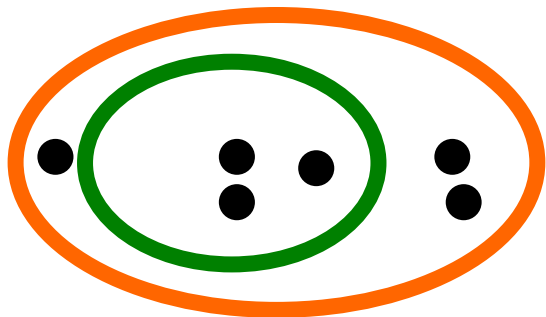


The principal problem of connecting wires

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- How we fail in connecting the wires
 - No wire overlap
 - Balloon cannot be advanced
 - Despite ballooning, not connecting



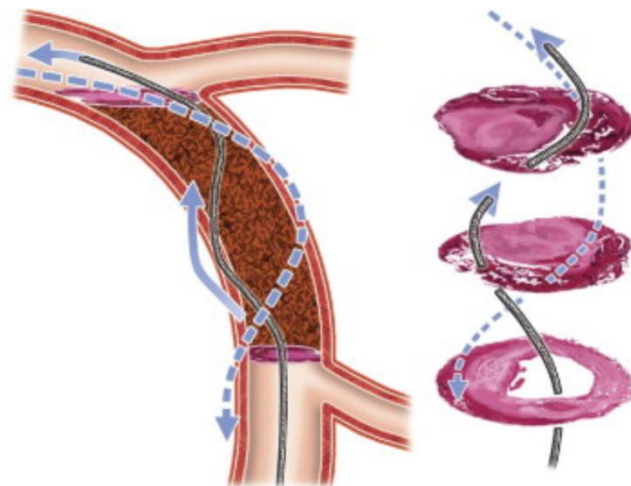


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- How we fail in connecting the wires
 - No wire overlap
 - Balloon cannot be advanced
 - Despite ballooning, not connecting
- Causes of failure
 - Calcifications
 - Angulations
 - Huge subintimal space
 - Undersizing of the balloon *)
 - ...



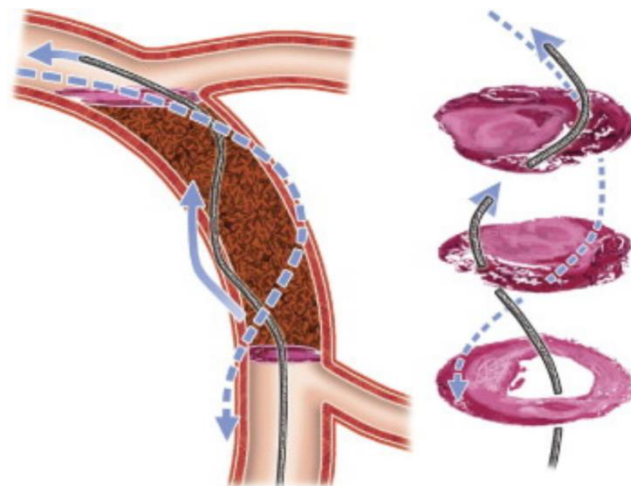


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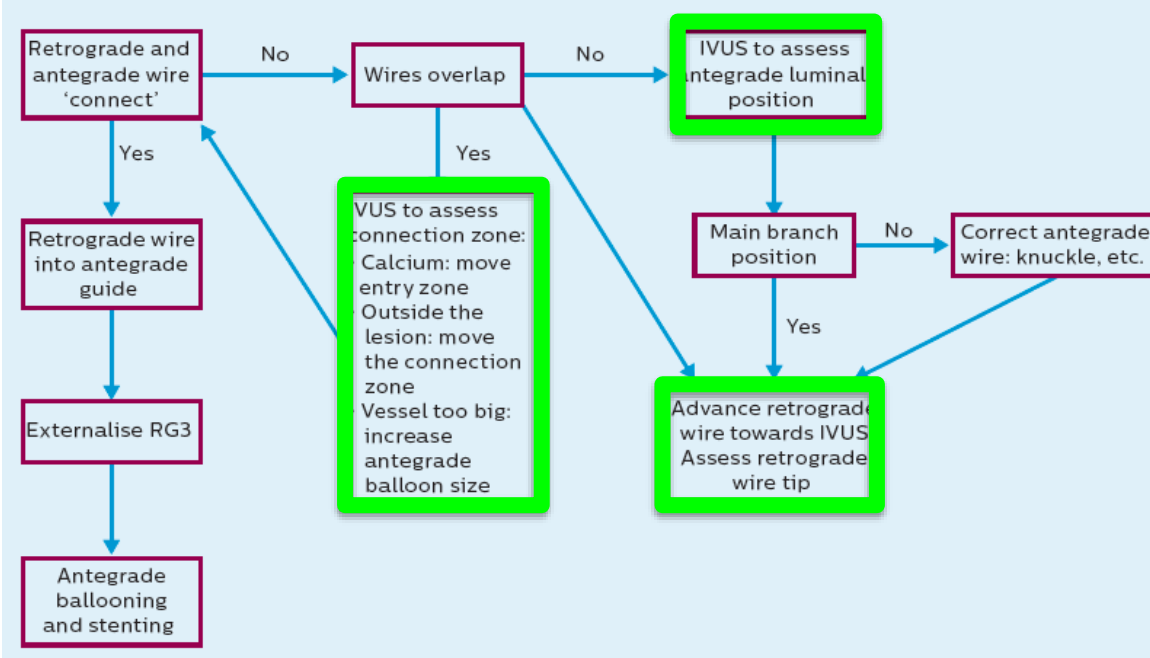
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- How we fail in connecting the wires
 - No wire overlap
 - Balloon cannot be advanced
 - Despite ballooning, not connecting
- Solutions
 - IVUS for understanding the problem
 - MSCT to understand the anatomy
 - Assisting with a Guideliner
 - Knuckle wire to overcome angulations



Practical use of IVUS in CTO interventions: IVUS in retrograde approach – reverse CART

How and when to perform IVUS in the retrograde approach

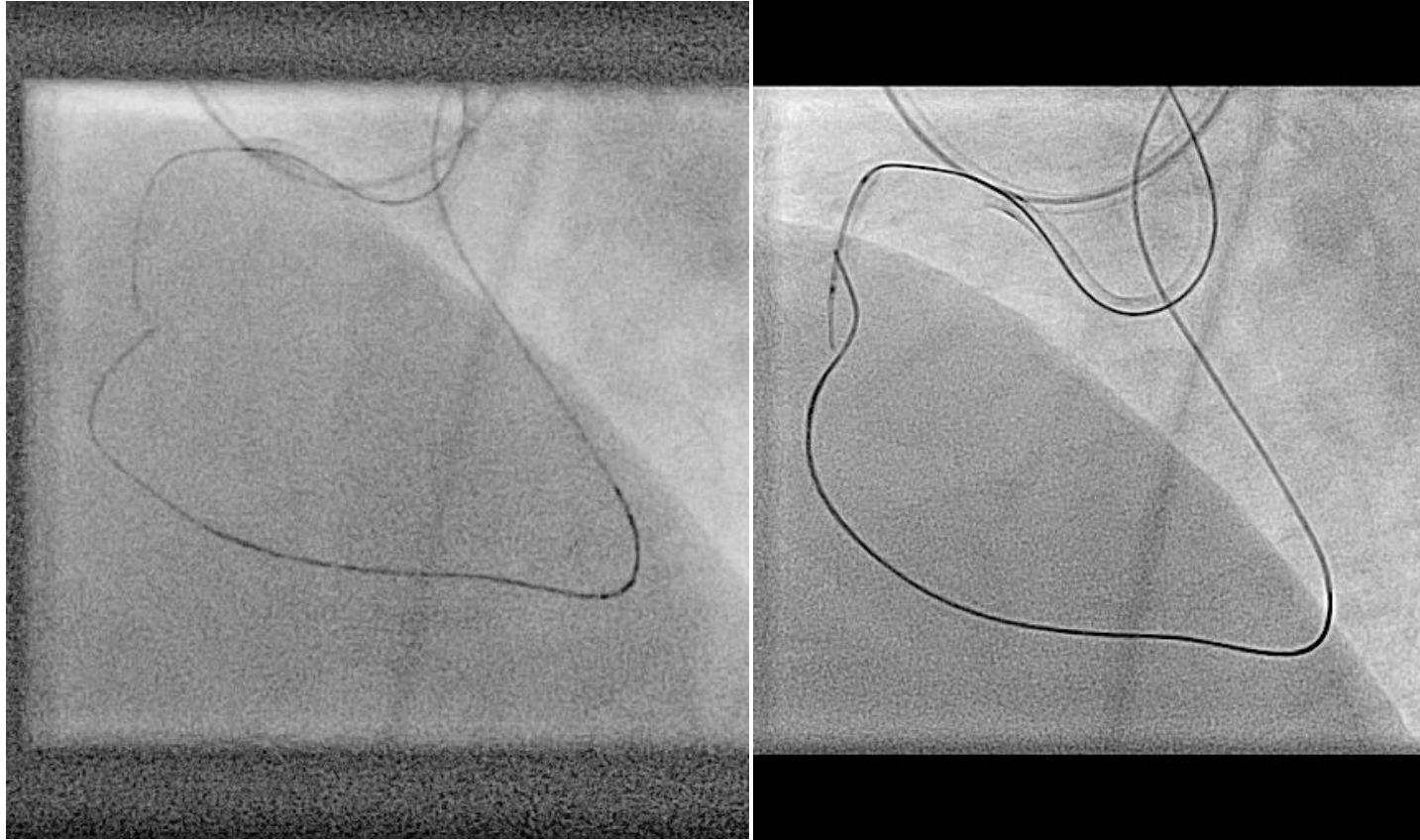


RCA CTO in a 77 year old man



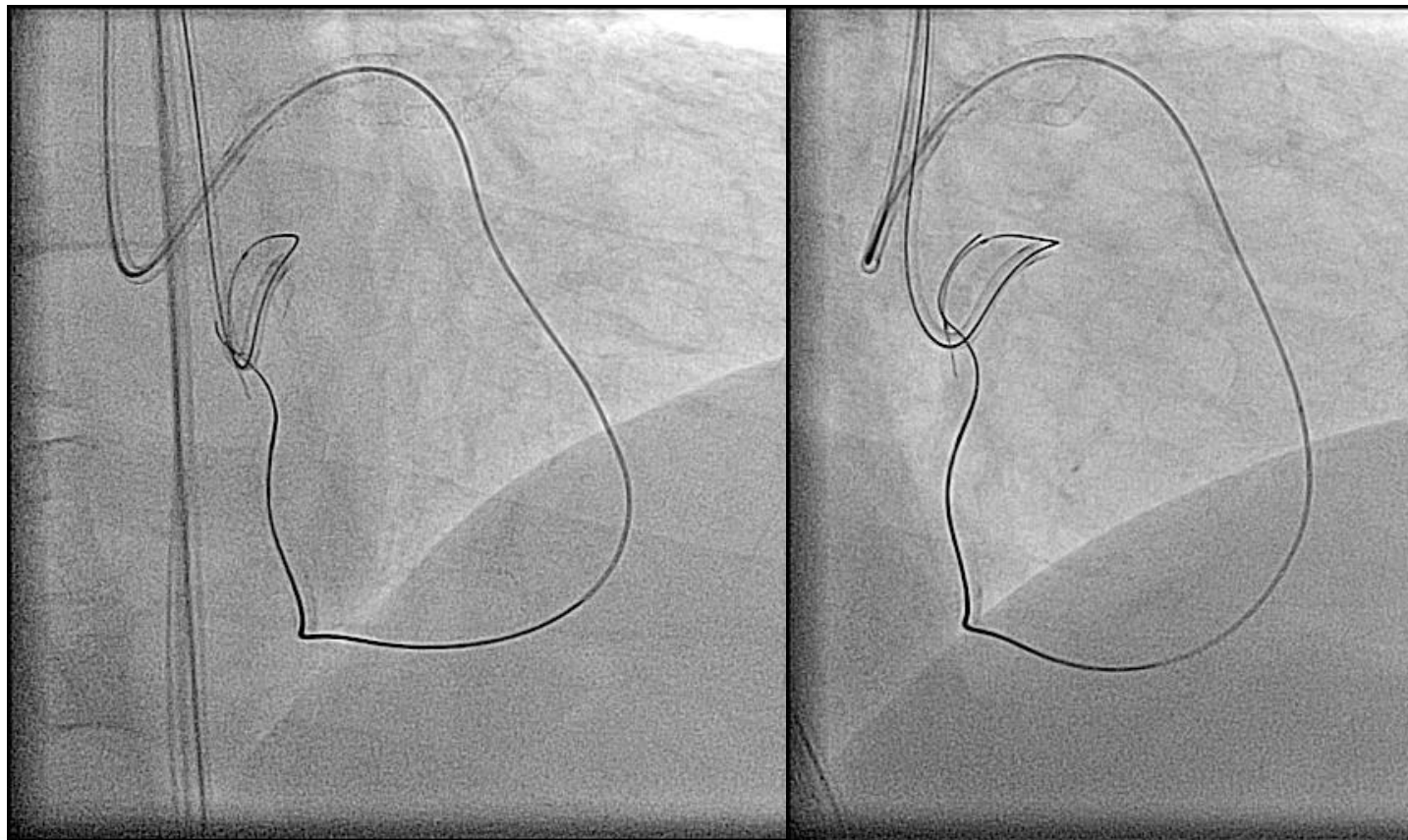


Bring wires in parallel position



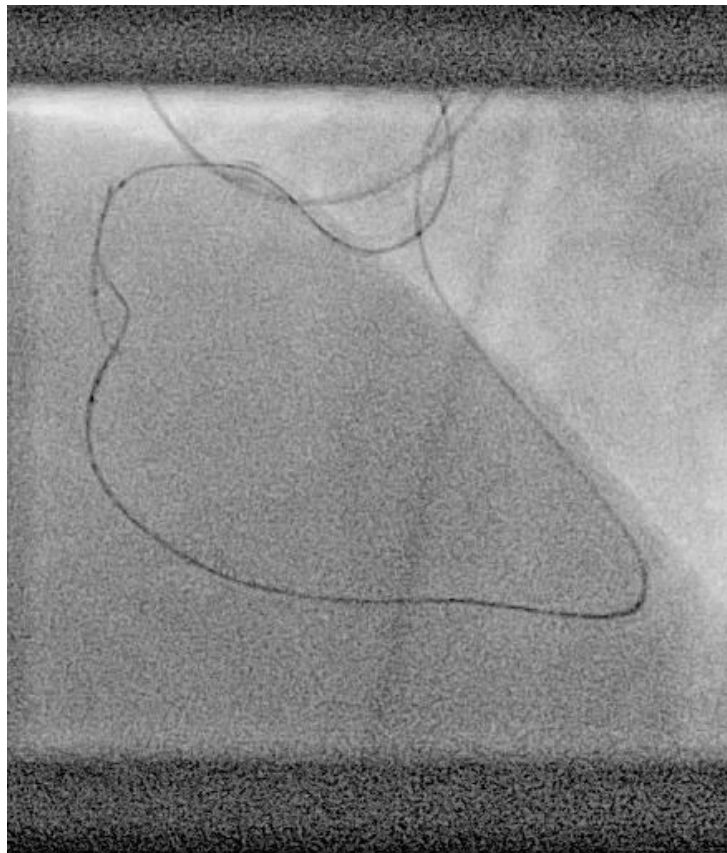


Overlap of the wires and connect by balloon inflation

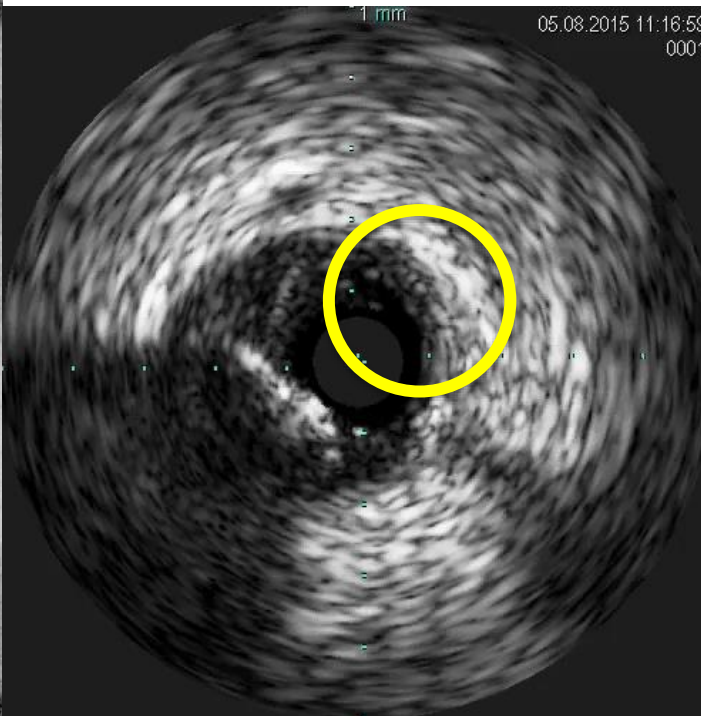




When wire progress stops, be aware of subintimal wire position



IVUS when ever there is doubt



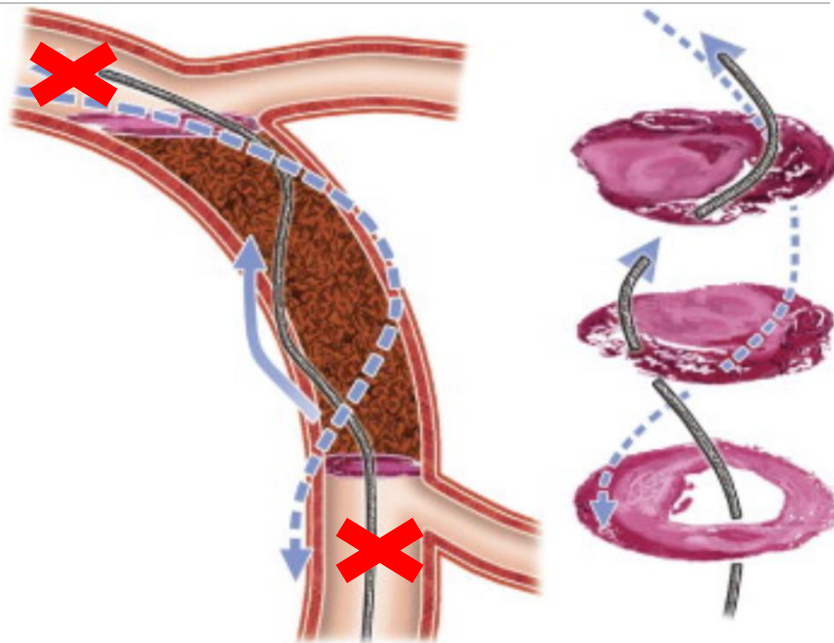
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Achieve a connection between antegrade and retrograde wire **inside** the plaque

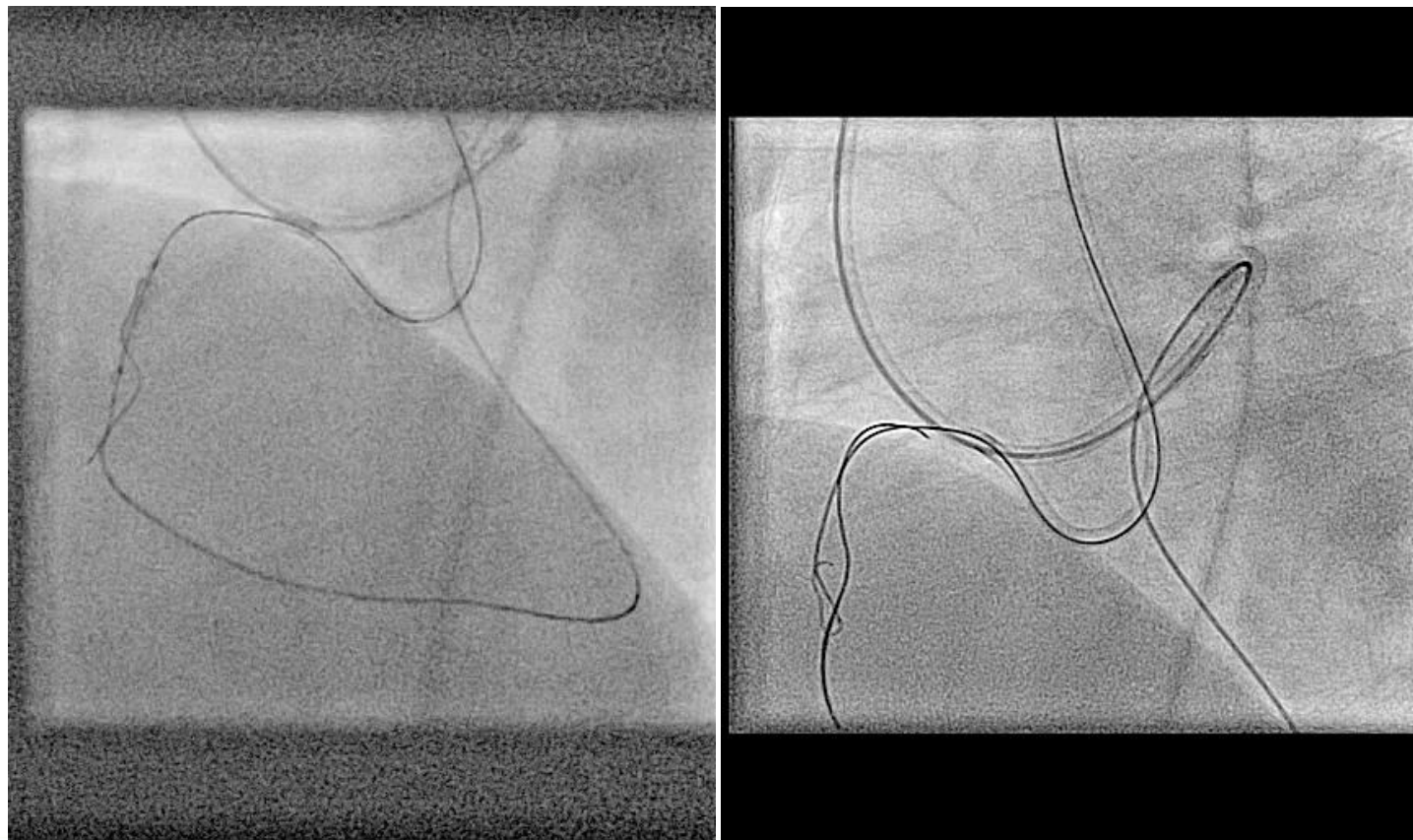
Reposition your wire to achieve a connection **inside** the plaque



How do we connect the wires ?

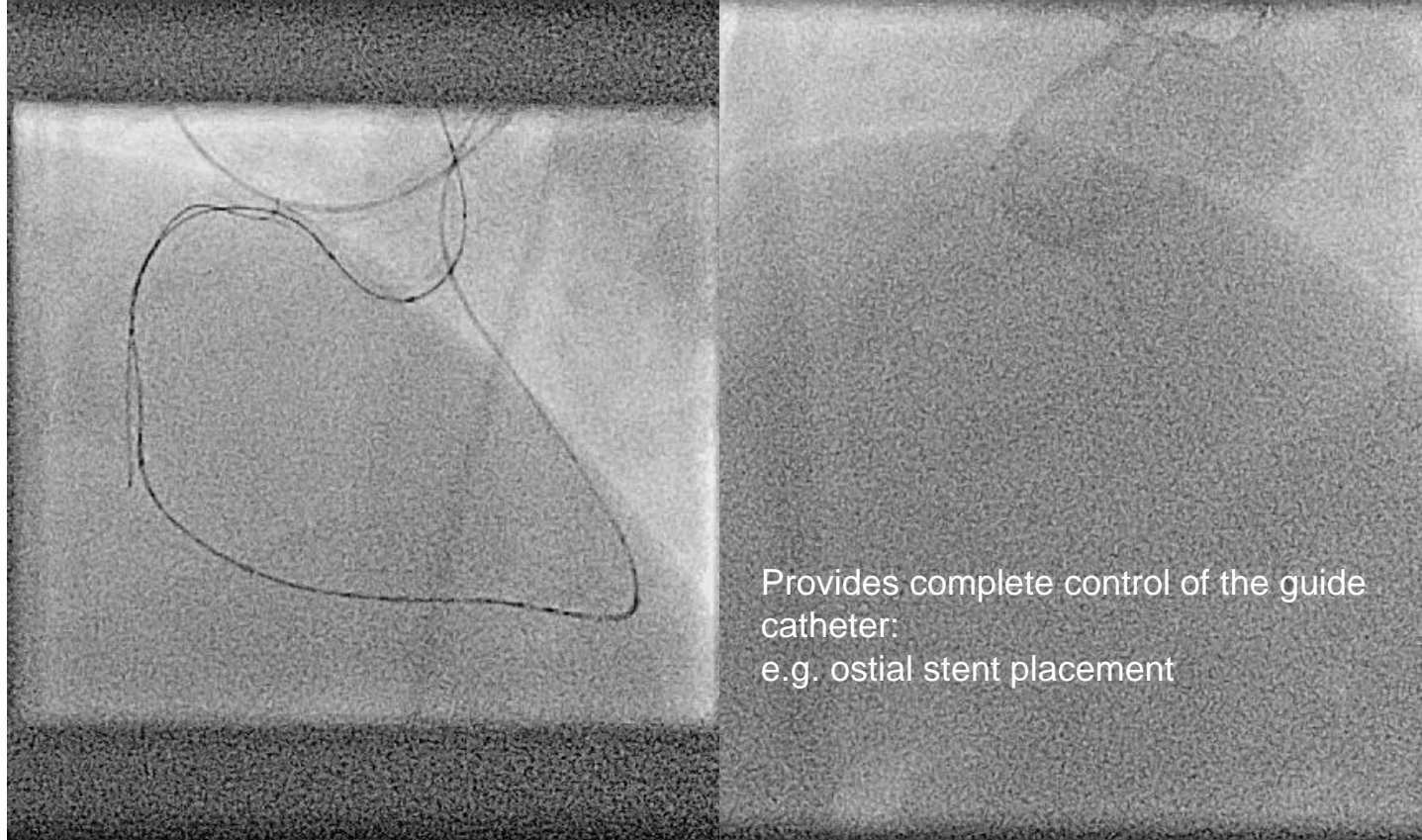


Repositioning of the entry zone distal into the lesion





The goal of the retrograde approach: externalization



Final result





Extremely high rate of subintimal tracking with US-strategy

FIGURE 4 Guidewire Tracking Pattern Compared With Angiography-Defined Successful Approach and Difficulty Grades

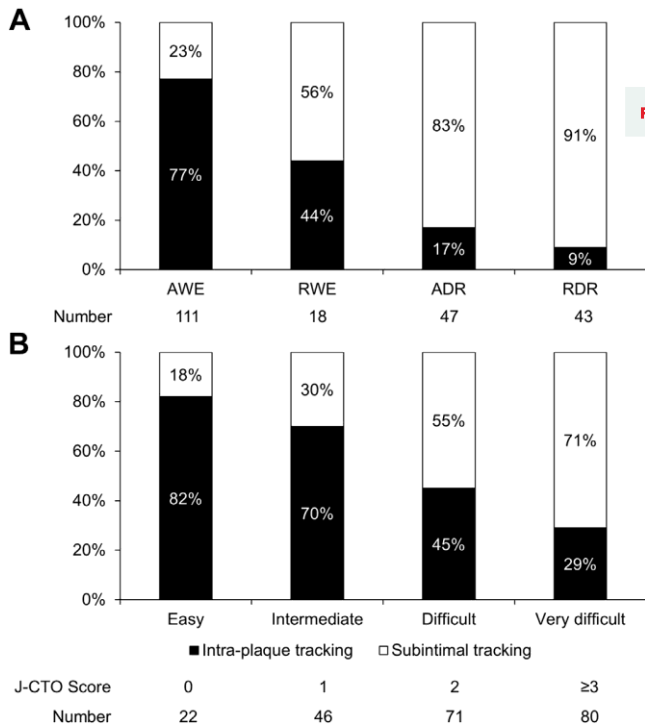
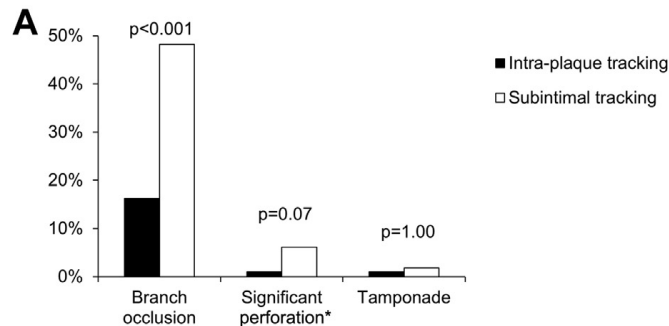


FIGURE 5 Procedure-Related Complications During CTO Intervention



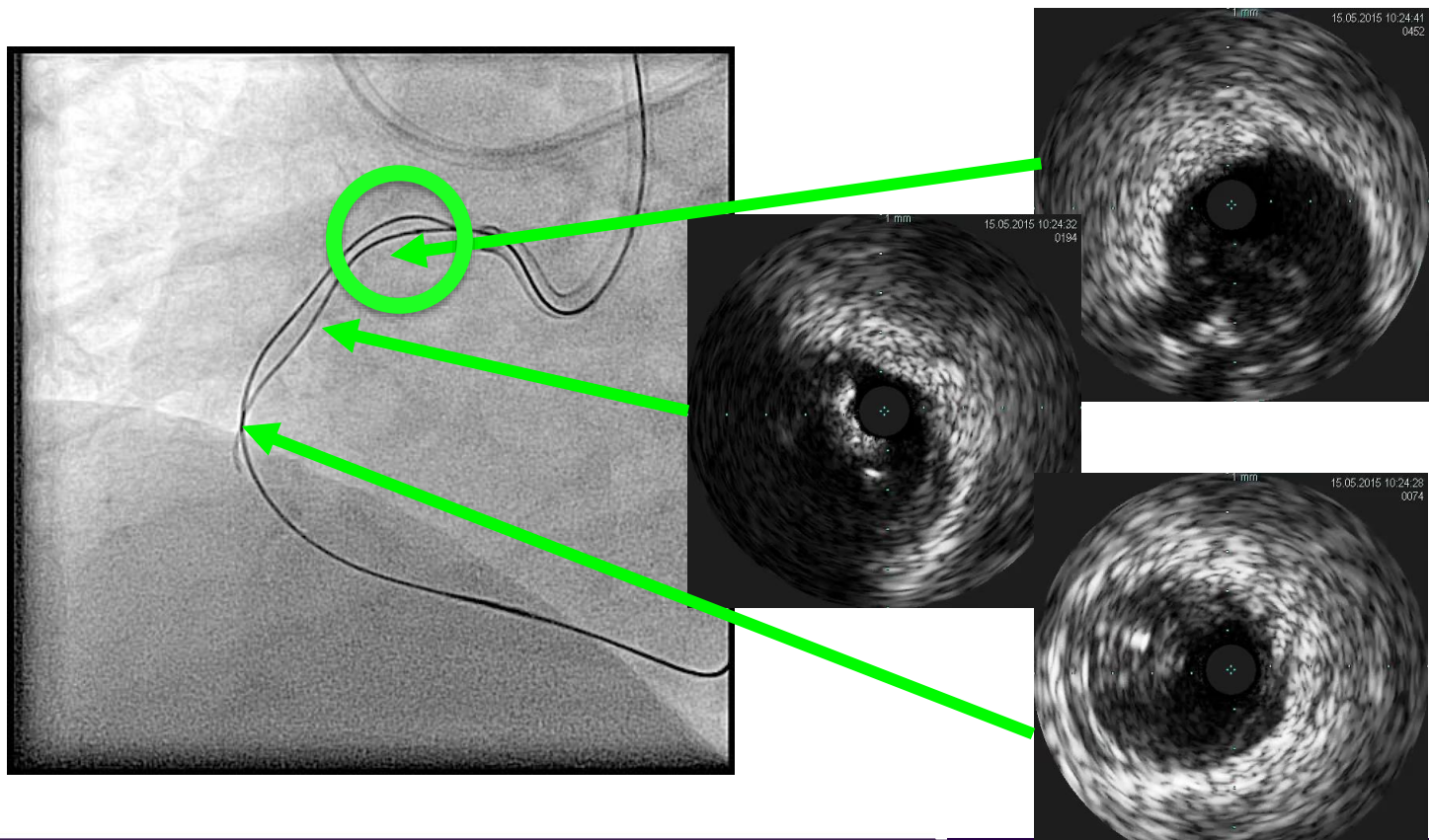


An example demonstrating RDR vs. anatomic approach



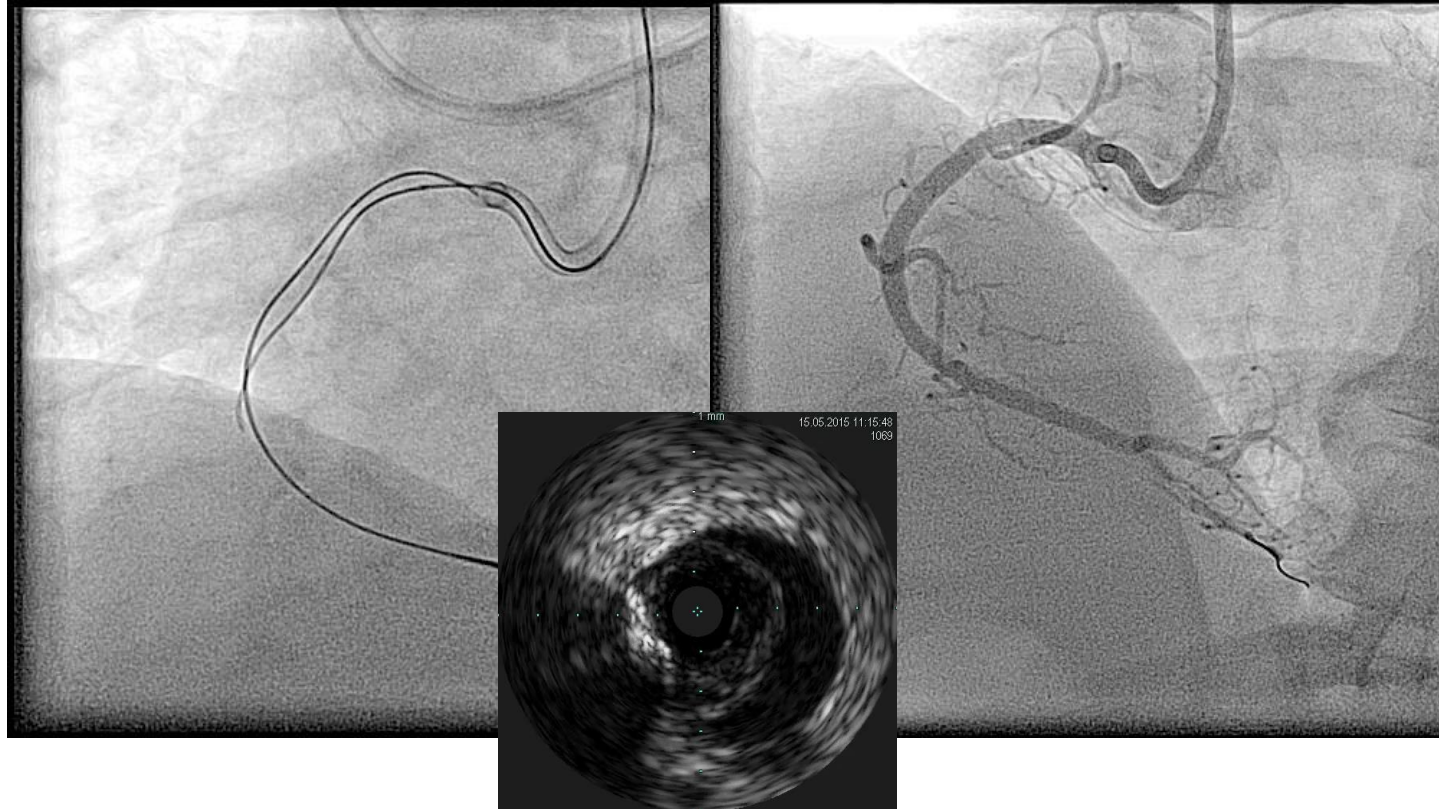


So we could do extensive CART, or antegrade rewiring



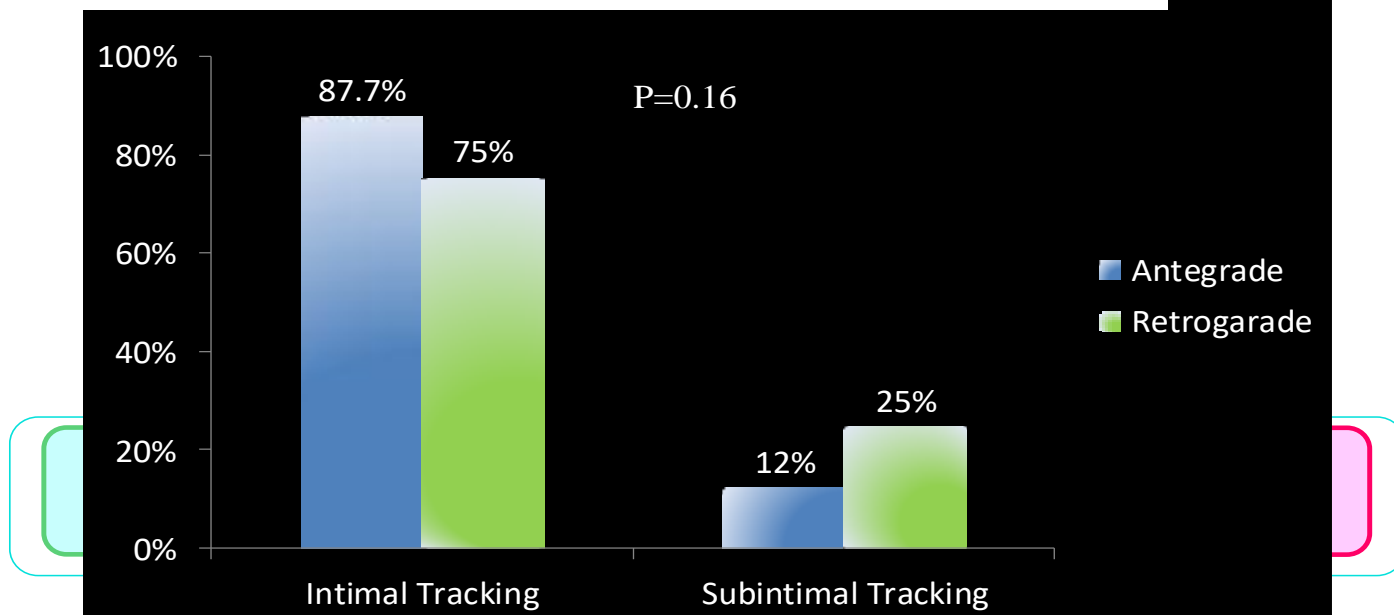


Change of position of reverse CART -> complete intimal passage and restored anatomy





The anatomical approach:
Even with the retrograde approach the
subintimal pathway is infrequent





The Essential Role of IVUS in CTO-PCI

- There is no RCT evidence for a long-term benefit of IVUS vs Angio-guided CTO PCI
- It should be possible to randomize a large number of patients to evaluate the clinical impact
- But IVUS is anyway an essential technical tool for achieving successful CTO PCI in complex antegrade and retrograde strategies
- IVUS is superior to angiography in long complex lesions, in many of these contrast injection should be avoided