



CTO UPDATE

Tips and Tricks

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Novembro - 2018

entusiasta

adjetivo e substantivo de dois gêneros

que ou o que se entusiasma.

- que ou o que é intensamente ou exageradamente dedicado a algo; que ou o que é tomado de arrebatamento, de admiração por alguém ou algo; fanático.
- que ou o que se exprime com entusiasmo.

Definições

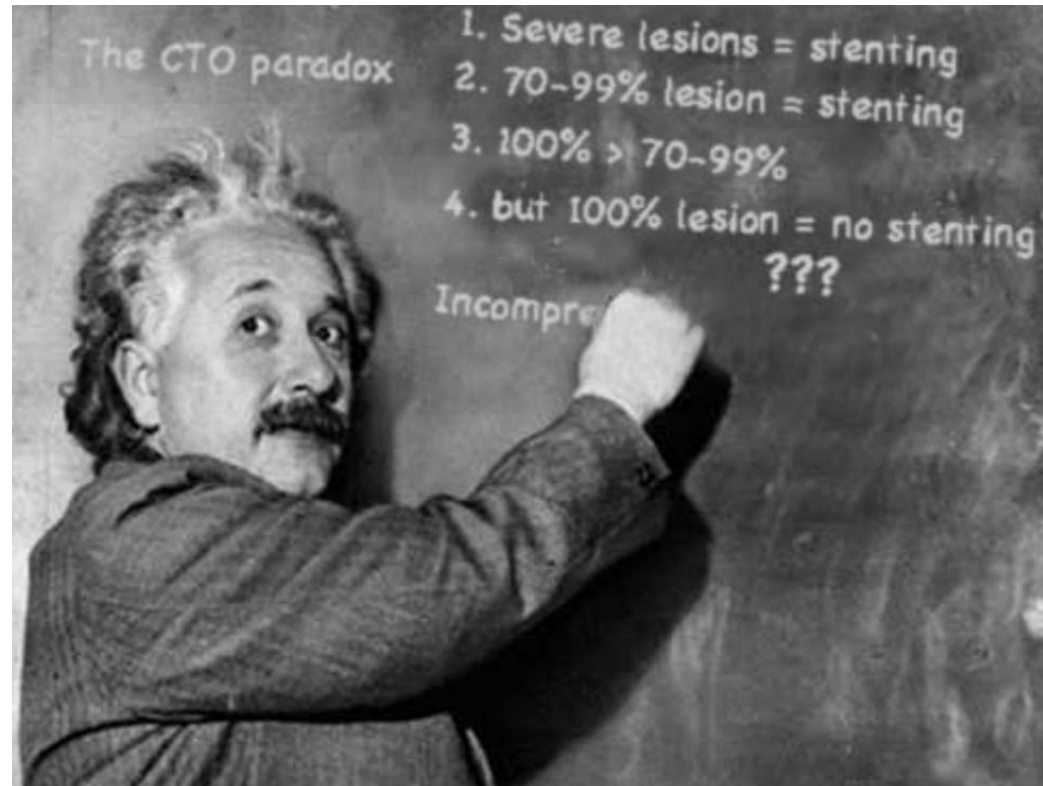
- CTO (CHRONIC TOTAL OCCLUSION) é definida como uma oclusão total em uma artéria TIMI flow grade 0 de pelo menos 3 meses de duração.
- Sucesso ICP é definido como sucesso angiográfico (estenose residual final <20% por estimativa visual e TIMI 3 depois da recanalização do CTO).
- Sucesso clínico é definido como um sucesso processual sem complicações.

DADOS CTO

- 20-30% CORONARIOGRAFIAS DIAGNÓSTICAS
- PRINCIPAL DETERMINANTE PARA CIRURGIA
- REVASCULARIZAÇÃO INCOMPLETA+TCO
- < 10% DAS INTERVENÇÕES
- NOVAS TECNOLOGIAS E TÉCNICAS->90% SUCESSO

“Well-developed collaterals do not have the ability to prevent ischemia in the supplied territory”

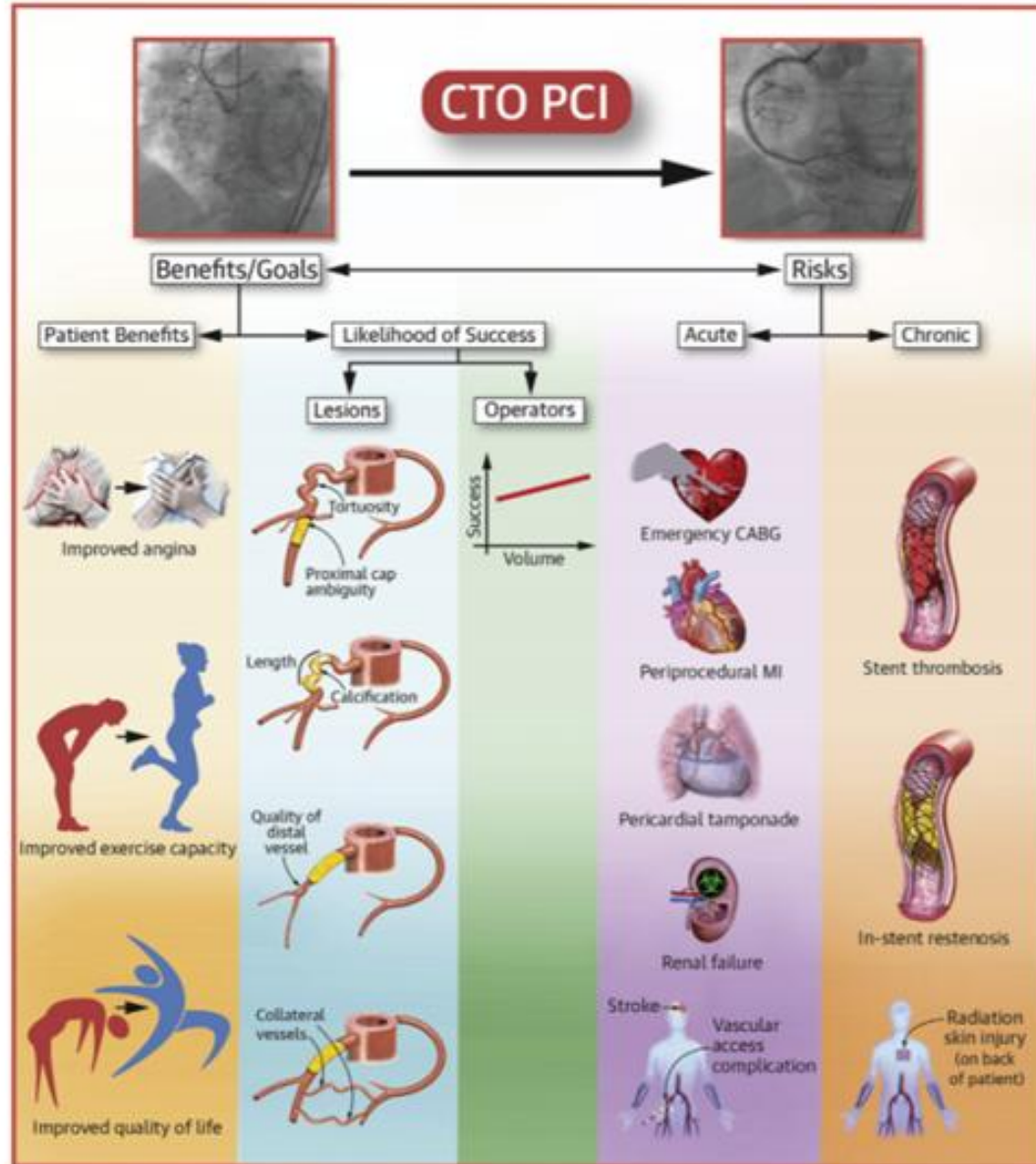
(Vo MN, Brilakis ES, Kass M, Ravandi A. Can. J. Physiol. Pharmacol 2015; 93: 1-5)

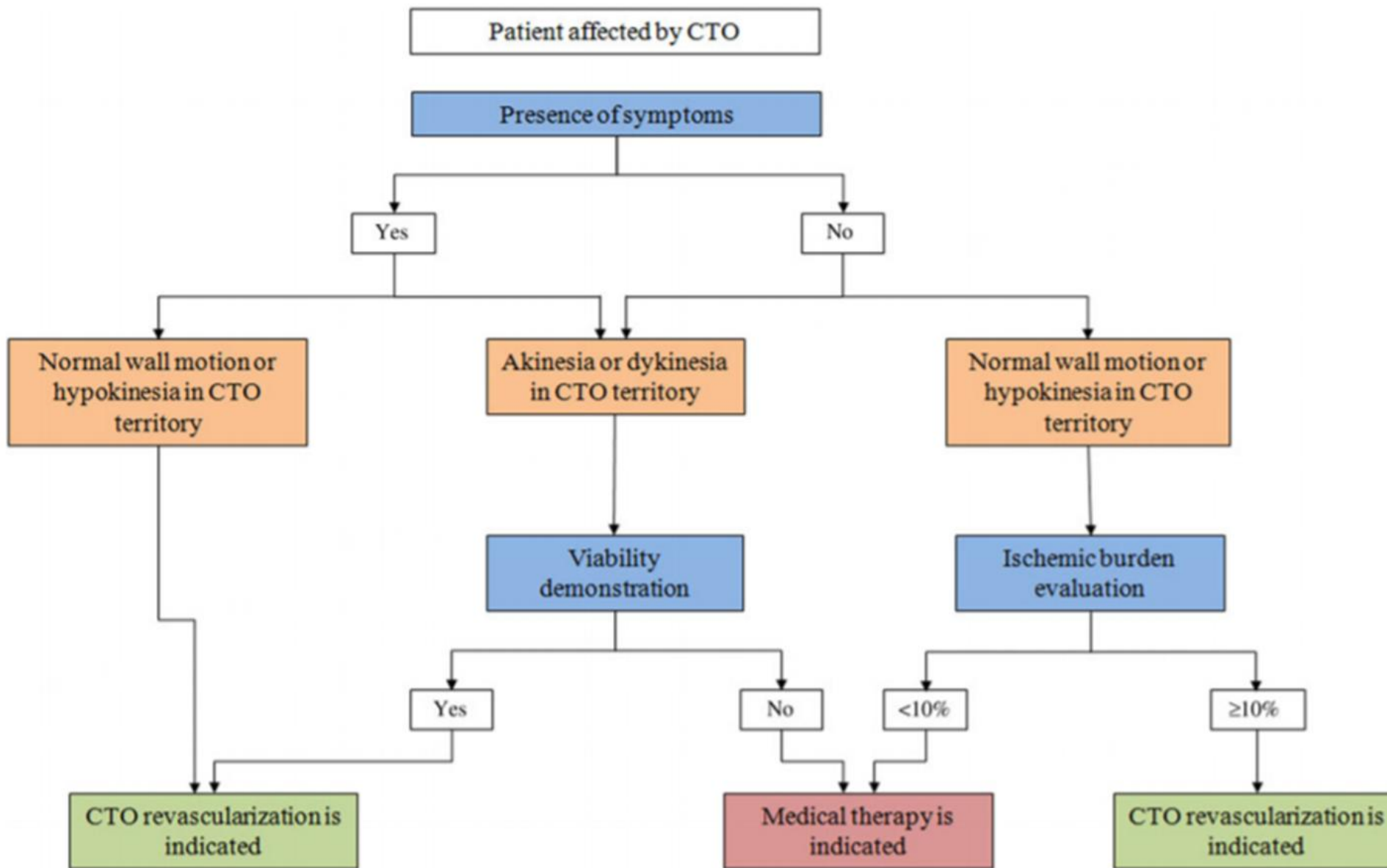


INDICAÇÃO

- SINTOMAS
- CARGA ISQUÊMICA $\geq 10\%$ -ALTO RISCO
- MELHORA FUNÇÃO VE (VIABILIDADE RNM)
- IMPACTO PROGNÓSTICO?
- ICP CTO está relacionado com a melhoria da sobrevida, melhora da angina e função ventricular esquerda, maior tolerância ao exercício e menor necessidade de revascularização miocárdica.

CENTRAL ILLUSTRATION Overview of the Potential Risks and Benefits of CTO PCI

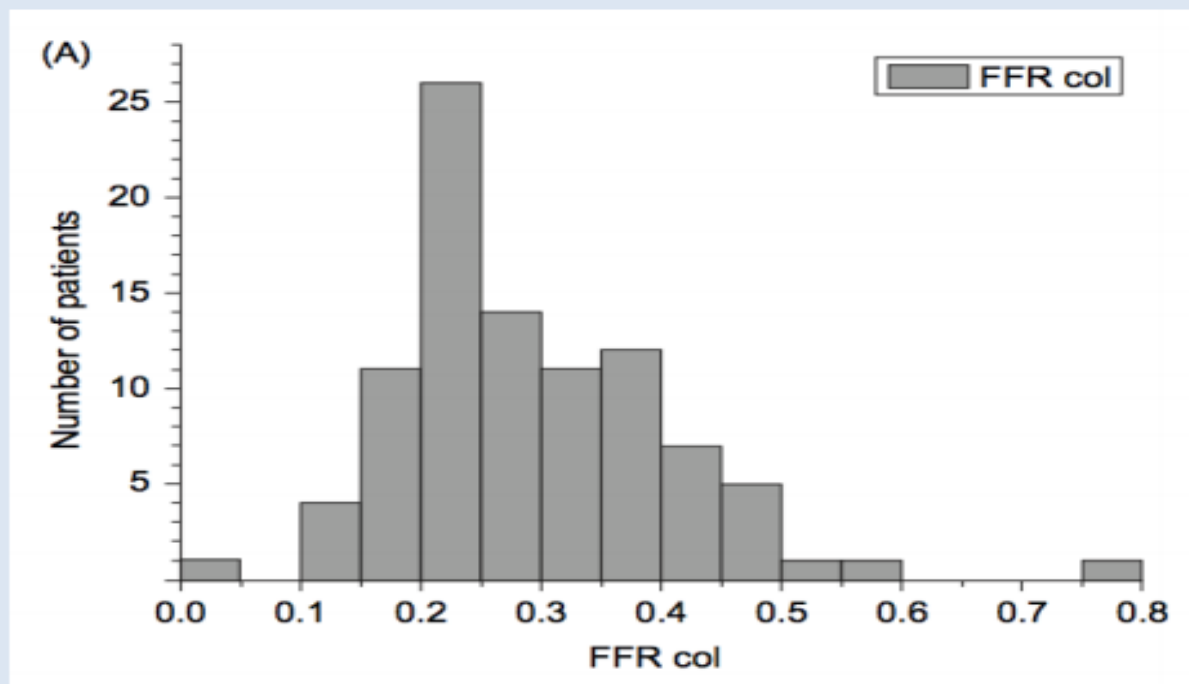




Collaterals “protection”

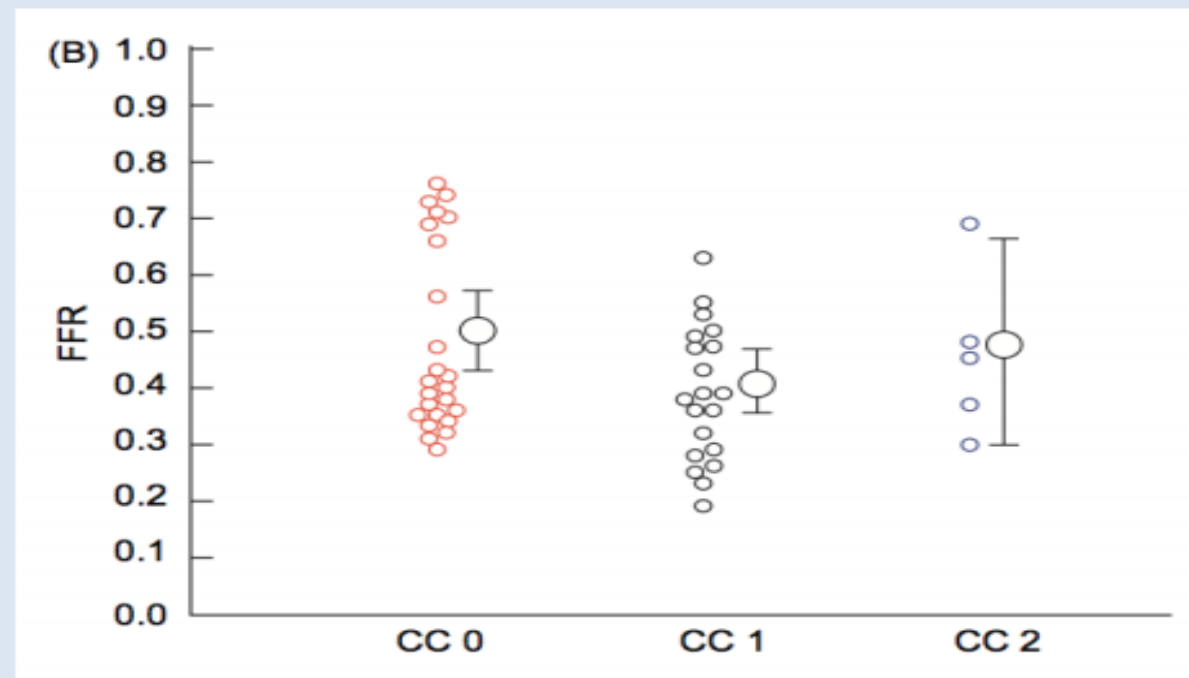
N=60 pts

FFR col in CTO



FFR POSITIVO

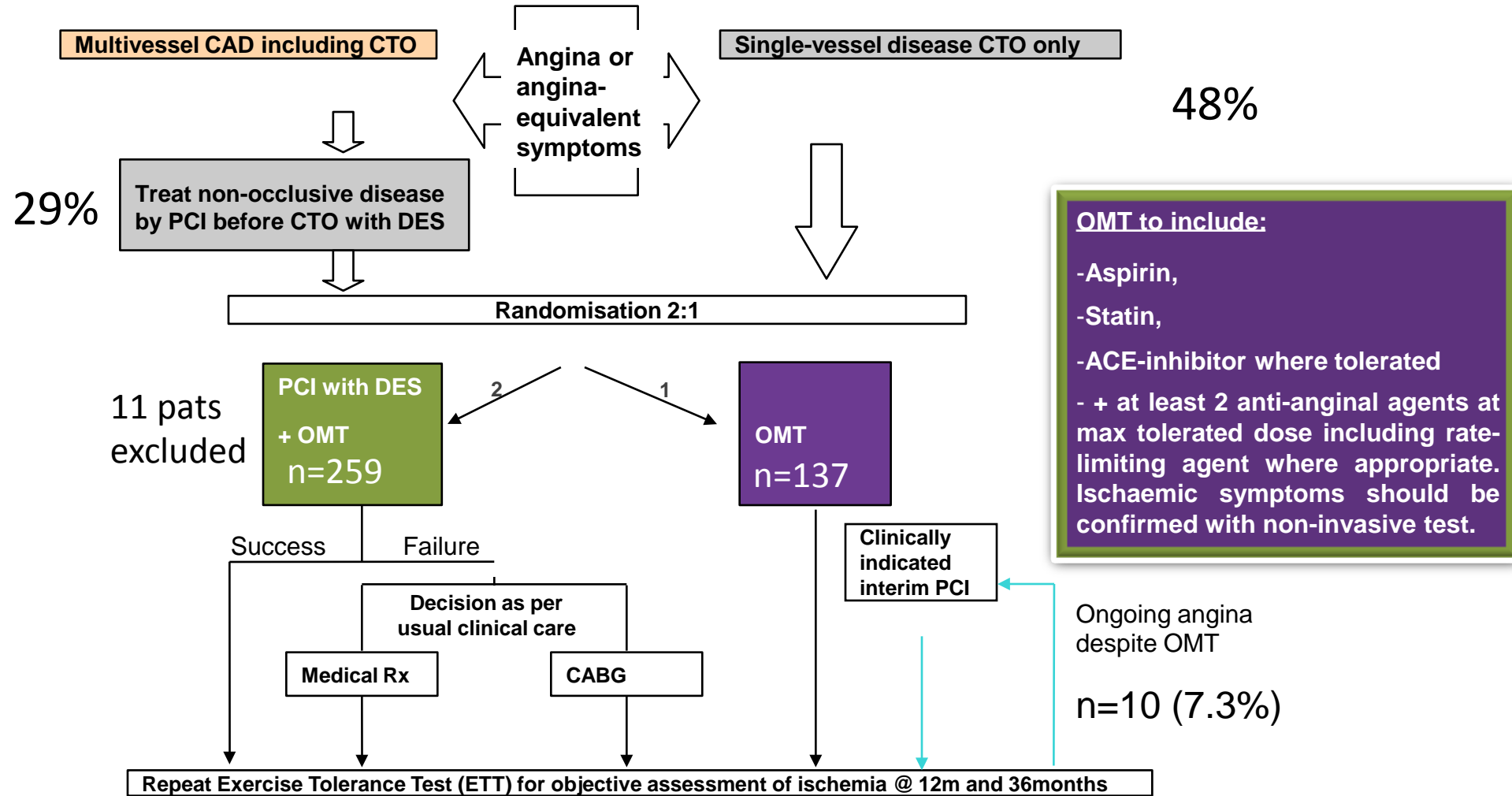
FFR col vs. CC Grade



ESTUDOS

- DECISION CTO TRIAL
- EURO CTO TRIAL
- THE EXPLORE TRIAL
- REVASC TRIAL

EUROCTO-Trial



OMT to include:

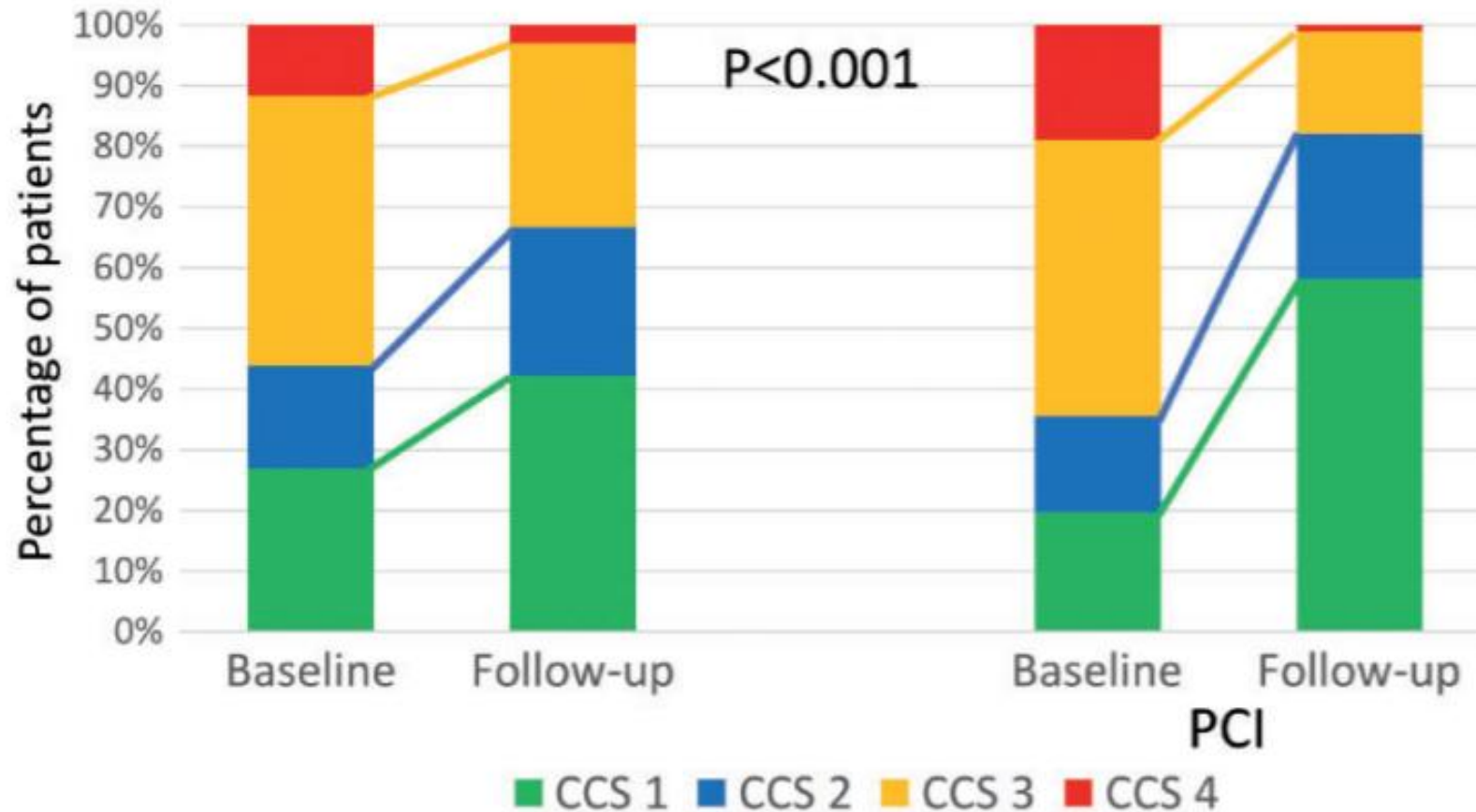
- Aspirin,
- Statin,
- ACE-inhibitor where tolerated
- + at least 2 anti-anginal agents at max tolerated dose including rate-limiting agent where appropriate. Ischaemic symptoms should be confirmed with non-invasive test.

Efficacy: Health status @ 12 and 36 months
Safety: Death, non-fatal myocardial infarction (ITT, PP) @ 36 months

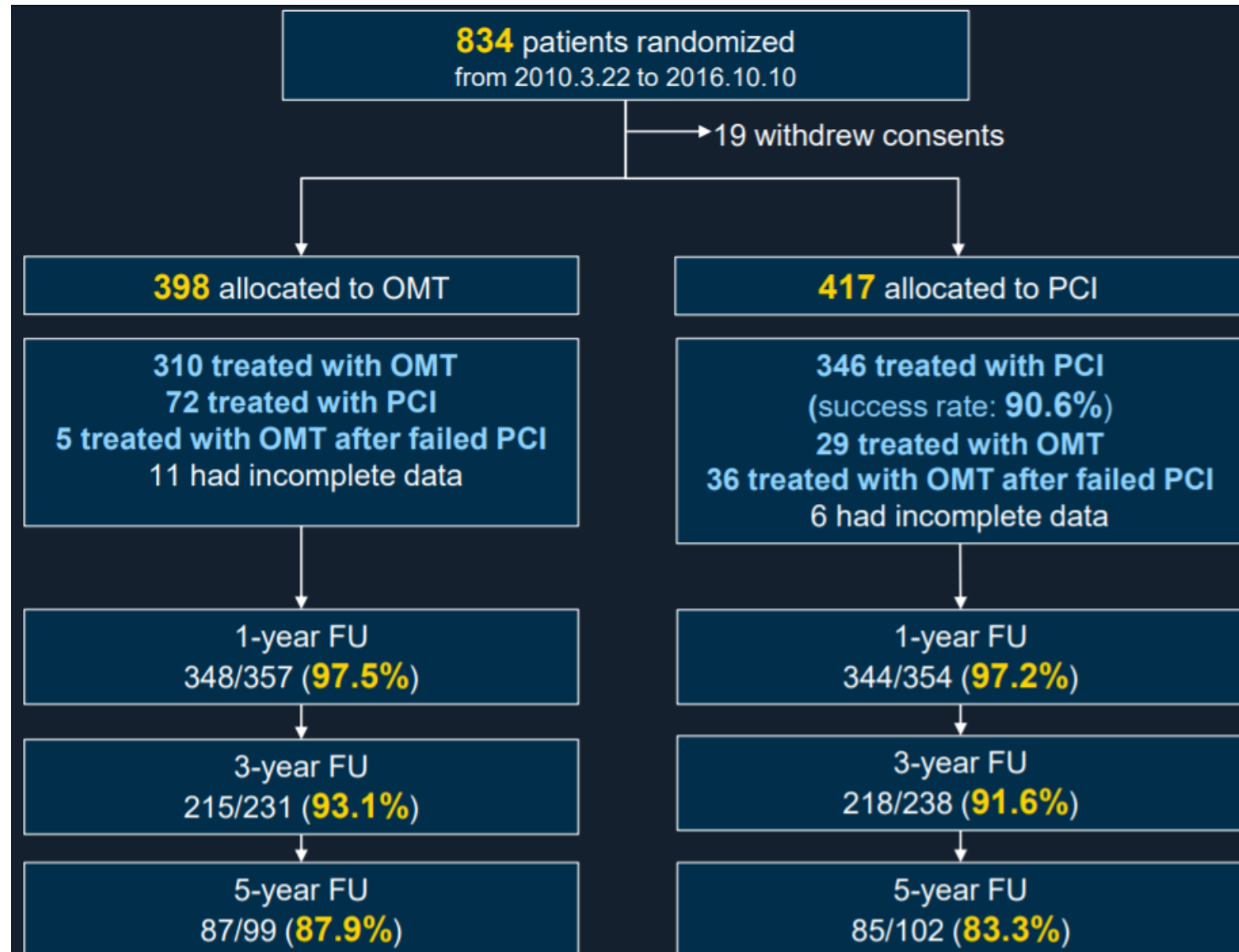
EUROCTO-Trial

Houve uma maior frequência de alívio completo da angina no grupo da ICP.

Os principais eventos cardiovasculares e cerebrovasculares adversos foram baixos e semelhantes entre os grupos de tratamento.



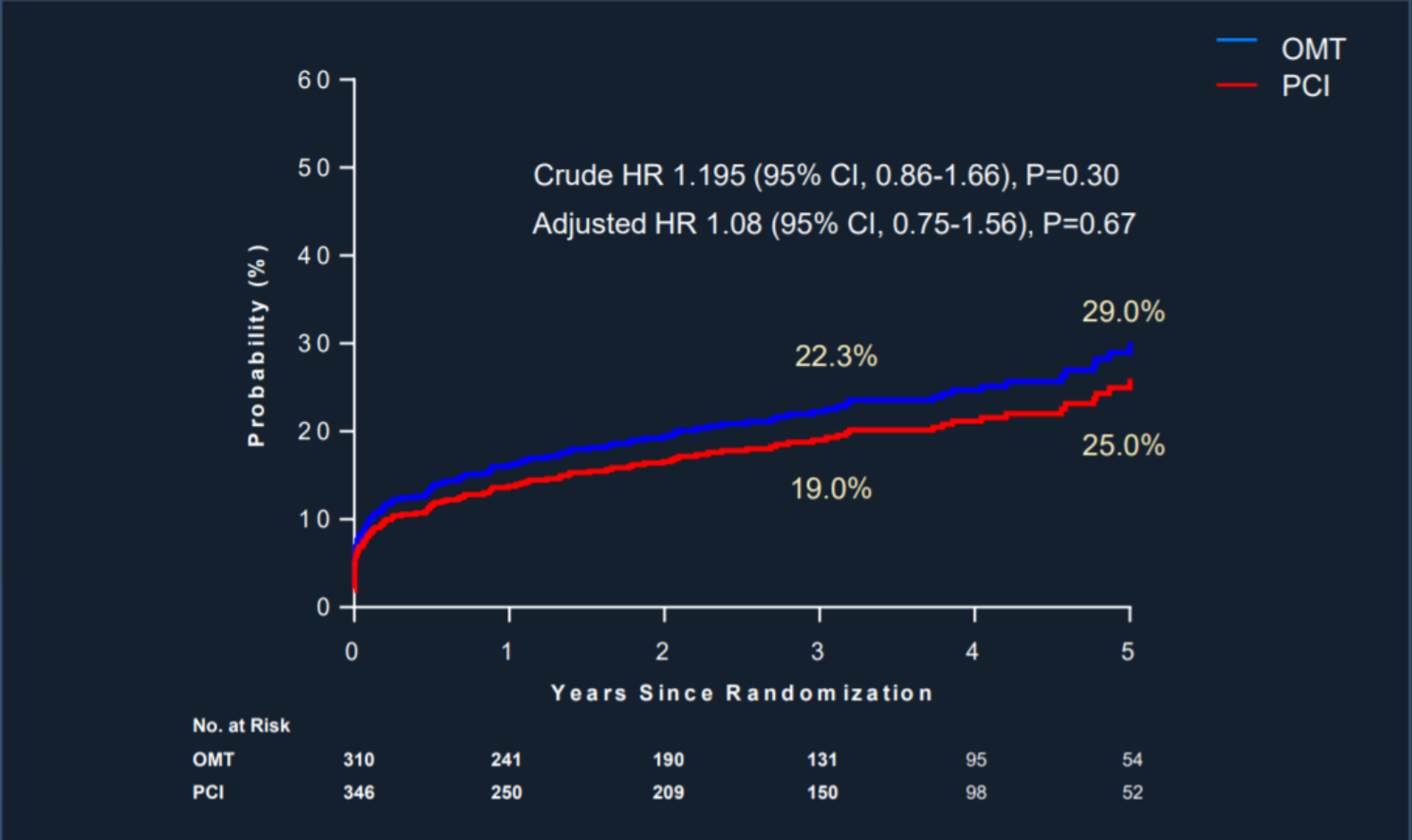
DECISION-CTO



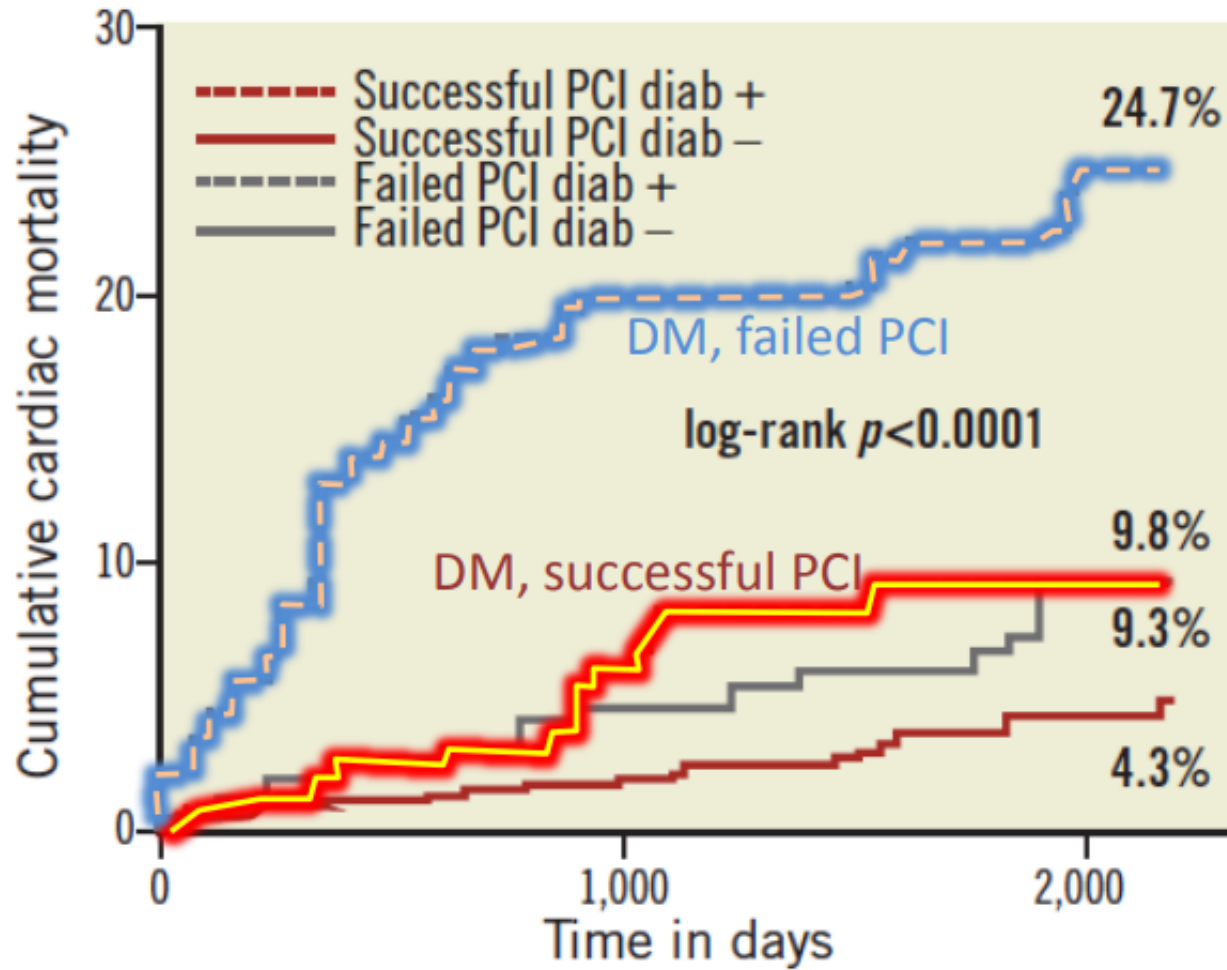
DECISION-CTO

Os resultados deste estudo indicam que a CTO-PCI + OMT de rotina não é superior à OMT isoladamente na redução dos desfechos cardiovasculares entre pacientes com pelo menos um CTO.

Primary End Point (Death, MI, Stroke, Any Repeat Revascularization)



Diabetic Patients Benefits from CTO PCI



		Asymptomatic			Symptomatic Class II			Symptomatic Class III-IV		
		Low risk	Interm. risk	High risk	Low risk	Interm. risk	High risk	Low risk	Interm risk	High risk
Single-vessel disease	CTO	I	U	U	U	U	A	U	A	A
	Non-CTO	I	U	A	U	A	A	A	A	A



		No left main involvement		Left main involvement		
		No LAD Low Syntax score	High Syntax score with LAD involvement	Low Syntax score	High Syntax score	
Multi vessel disease	CTO	PCI	A	U	U	I
		CABG	A	A	A	A
	Non-CTO	PCI	A	U	A	I
		CABG	A	A	A	A



I	Inappropriate	U	uncertain	A	Appropriate
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Guidelines

4.7. PCI in Specific Anatomic Situations

4.7.1. Chronic Total Occlusions

CLASS IIa

1. PCI of a chronic total occlusion in patients **with appropriate clinical indications** and **suitable anatomy** is reasonable when performed by **operators with appropriate expertise** (373–377).
(Level of Evidence: B)

Recommendations for the treatment of specific lesion subsets.

Recommendations	Class ^a	Level ^b	Ref ^c
DES should be considered for PCI of ostial lesions.	IIa	B	769–772
For PCI of bifurcation lesions, stent implantation in the main vessel only, followed by provisional balloon angioplasty with or without stenting of the side branch, should be the preferred treatment.	IIa	A	725–731
Percutaneous recanalization of CTOs should be considered in patients with expected ischaemia reduction in a corresponding myocardial territory and/or angina relief .	IIa	B	740–743, 745
Retrograde recanalization of CTOs may be considered after a failed anterograde approach or as the primary approach in selected patients.	IIb	C	

2018 ESC/EACTS Guidelines on myocardial revascularization

Recommendations on specific lesion subsets

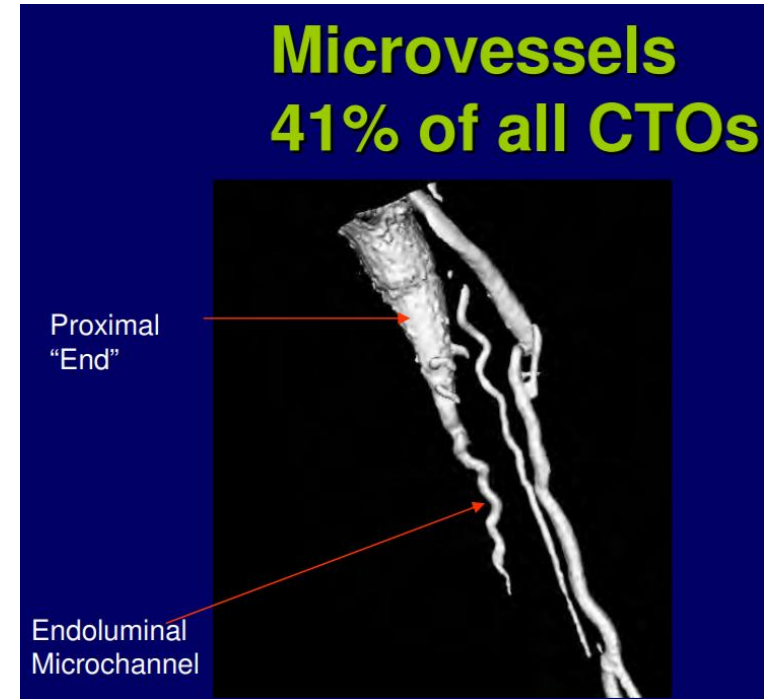
Recommendations	Class ^a	Level ^b
Stent implantation in the main vessel only, followed by provisional balloon angioplasty with or without stenting of the side branch, is recommended for PCI of bifurcation lesions. ^{654–658}	I	A
Percutaneous revascularization of CTOs should be considered in patients with angina resistant to medical therapy or with a large area of documented ischaemia in the territory of the occluded vessel. ^{629,659–663}	IIa	B
In true bifurcation lesions of the left main, the double-kissing crush technique may be preferred over provisional T-stenting. ⁶²⁰	IIb	B

Planejamento

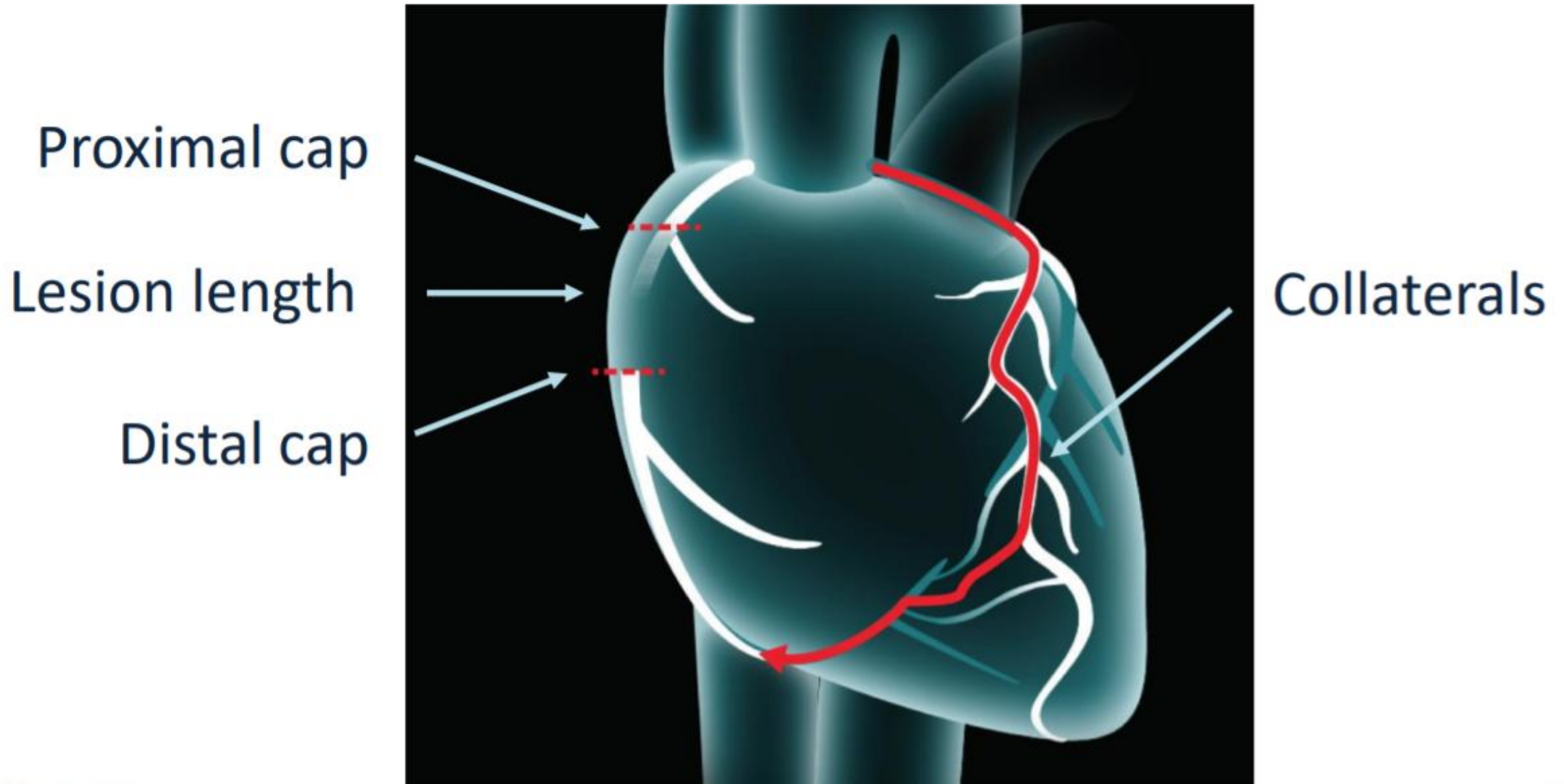
- Primeiro passo!!!

Angiografia CTO







- Dupla injeção
- Selecione as projeções ideais
- Configurar a imagem
- Baixa magnificação
- Injeções sequenciais
- Aquisições mais longas
- Uso judicioso da radiação e contraste
- AngioTC prévia p/ maiores informações se necessário

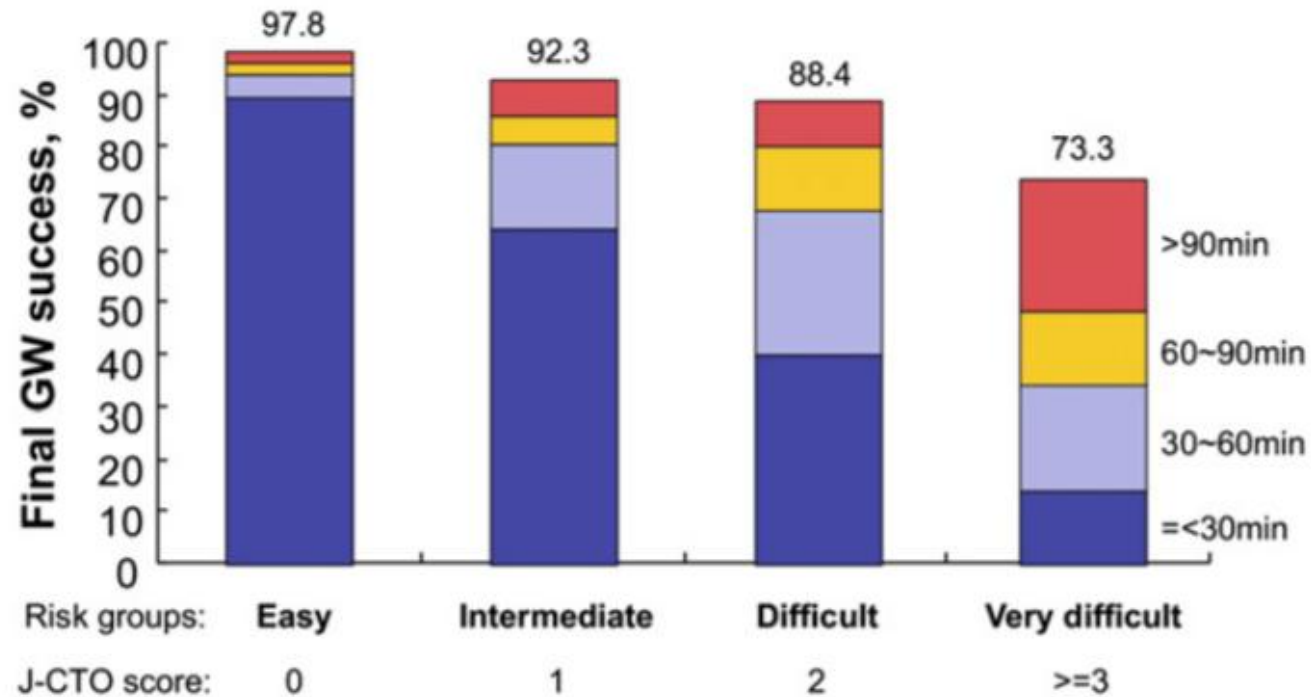


CTO Angiogram Evaluation



A) J-CTO SCORING SYSTEM

Entry shape of lesion		Calcification	Lesion bending >45°	Length of occlusion	Previous failed attempt
Tapered 	Blunt 		>45° 	Occlusion length 	
Tapered=0 Blunt=1 Tapering at proximal cap scores 1		None=0 Present=1	No=0 Yes=1	<20 mm=0 ≥20 mm=1	No=0 Yes=1
0=Easy		1=Intermediate	2=Difficult		≥3=Very difficult





PROGRESS-CTO

Prospective Global Registry for the Study of Chronic Total Occlusion Intervention

CTO Score Calculator

Patient initials:

Target vessel	Lesion calcification	Occlusion length
<input checked="" type="radio"/> LAD <input type="radio"/> LCX <input type="radio"/> RCA	<input type="radio"/> None <input checked="" type="radio"/> Mild/moderate <input type="radio"/> Severe	<input type="radio"/> <20 mm <input checked="" type="radio"/> ≥20 mm

Ostial location	Proximal cap ambiguity	Stump
<input checked="" type="radio"/> No <input type="radio"/> Yes	<input type="radio"/> No <input checked="" type="radio"/> Yes	<input checked="" type="radio"/> Tapered <input type="radio"/> Blunt

Proximal vessel tortuosity	Bending (intra-lesion)
<input checked="" type="radio"/> None/mild <input type="radio"/> Moderate/severe (1 bend > 90° or 2 bends > 70°)	<input type="radio"/> ≤45° <input checked="" type="radio"/> >45°

CL score

1.5

Score	Technical success
0 - 1.0	88.3%
1.5 - 2.5	73.1%
3.0 - 4.5	59.4%
≥ 5.0	46.2%

[Alessandrino et al., JACC Cardiovasc Interv. 2015 Oct; 8:1540-8](#)

J-CTO score

3

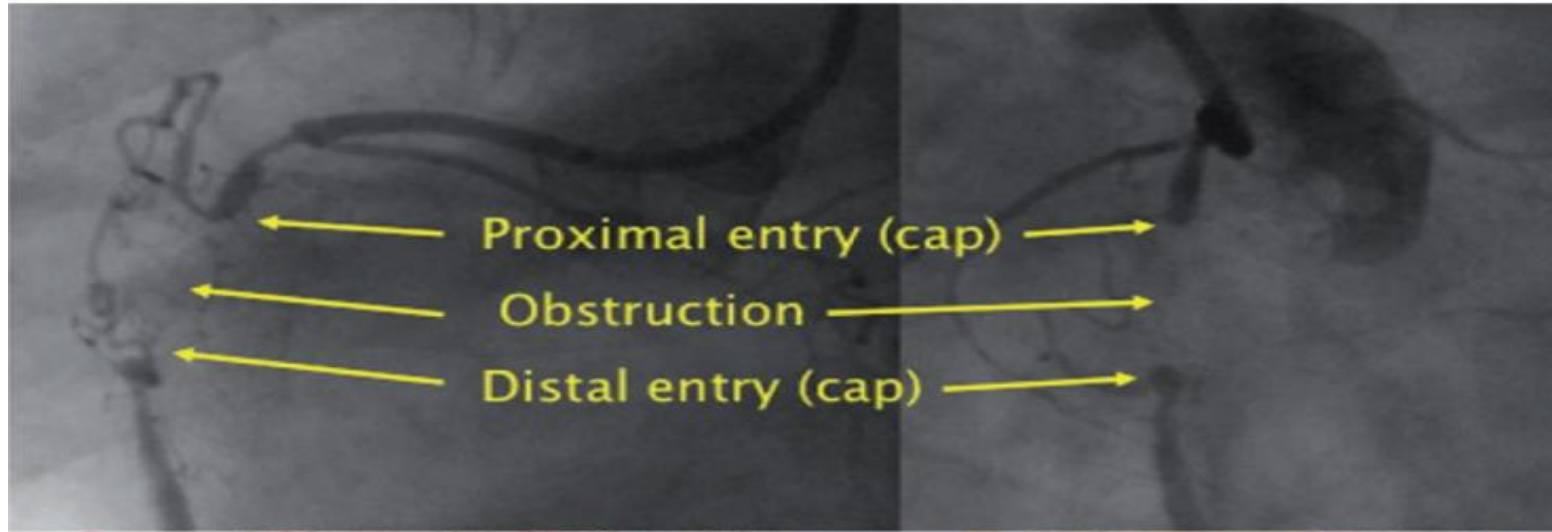
Score	Probability of crossing in <30 minutes
0	92.3%
1	58.3%
2	34.8%
≥ 3	22.2%

[Morino et al., JACC Cardiovasc Interv. 2011 Feb; 4:213-21](#)

PROGRESS CTO score

1

Score	Technical success
0	98.2%
1	97.5%
2	91.6%

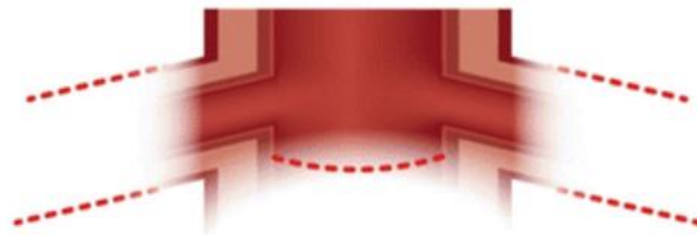
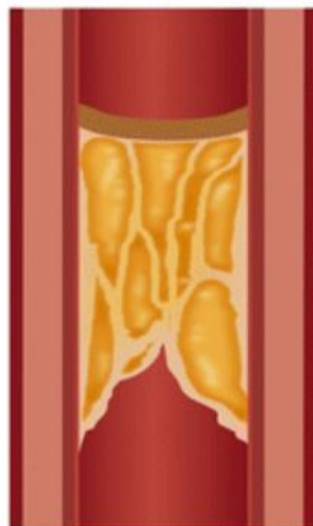


**A key determinant of initial strategy
is the proximal cap**

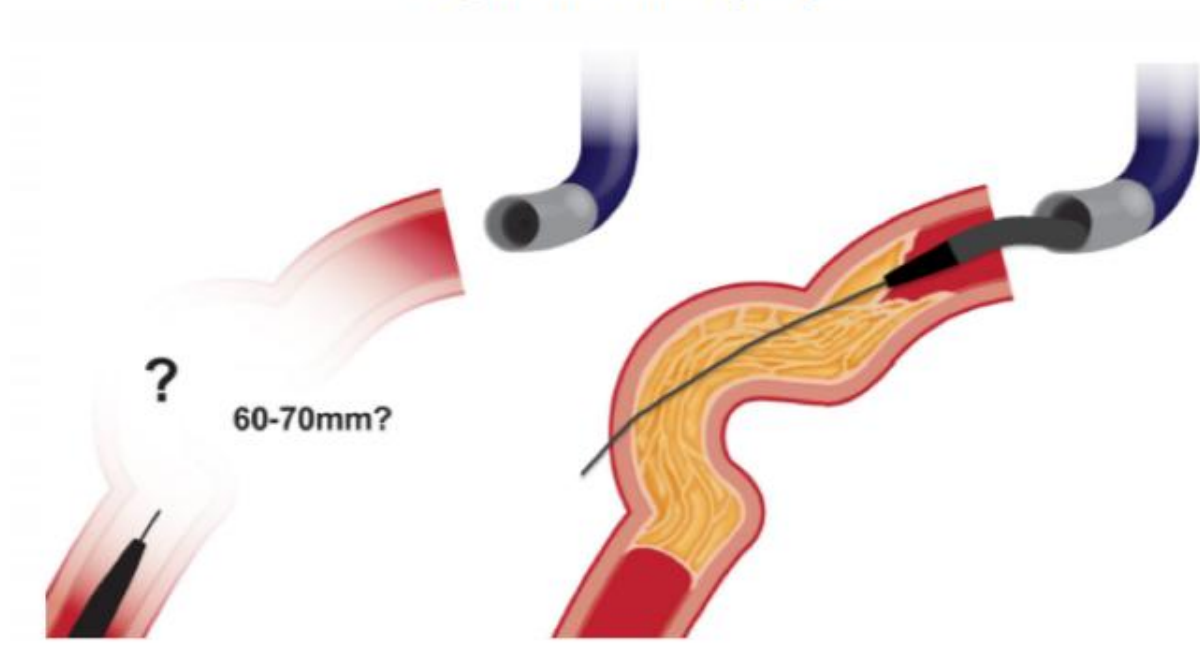
Tapered cap

Blunt cap

Ambiguous Cap



**Consequences of Proximal Cap and CTO
segment Ambiguity?**



Avaliação Angiografia

Capa Proximal

- Ambígua ou não ambígua?
- abrupto ou cônico?
- Ramificação lateral no pCap?
- Calcificado?

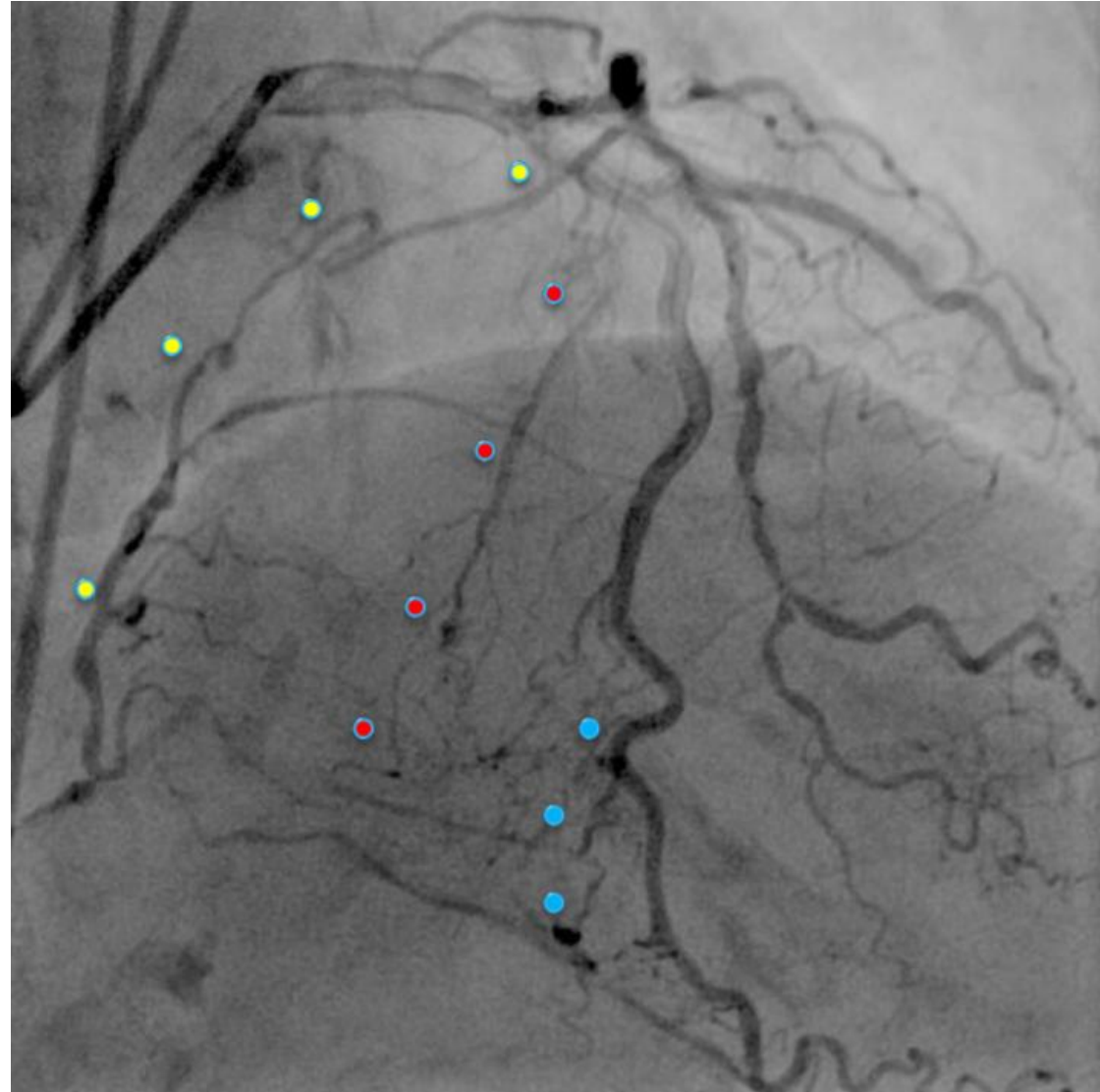
Capa Distal

- Ambígua ou não ambígua?
- abrupto ou cônico?
- dCap na bifurcação?
- Tamanho do vaso distal / doença além do dCap?

Comprimento da oclusão

- Comprimento < ou > 20mm?
- [Preditor em cruzar a guia]

Circulação colateral



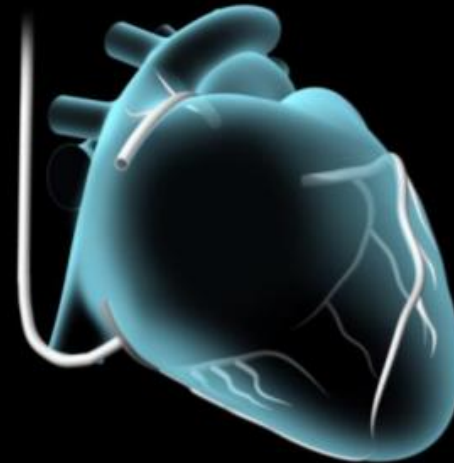
Collateral Type



Septal



Epicardial



SVG



LIMA

Circulação colateral

Table 1: Rentrop and Werner Classification of Coronary Collateral Circulation

Rentrop Classification¹⁵ (Developed for Occluded and Non-occluded Arteries)

0	no filling of collateral vessels
1	filling of collateral vessels without any epicardial filling of the target artery
2	partial epicardial filling by collateral vessels of the target artery
3	complete epicardial filling by collateral vessels of the target artery (In CTOs, Rentrop 3 is prevalent in 85% of lesions)

Collateral Connection Grade¹³

CC0	no continuous connection
CC1	threadlike continuous connection
CC2	side branch-like connection (≥ 0.4 mm)
CC3	>1 mm diameter of direct connection (not included in the original description)

CTO = chronic total occlusion.

CC ideal

- Tamanho da coletaral
- < Tortuosidade
- Ausência estenose do ramo

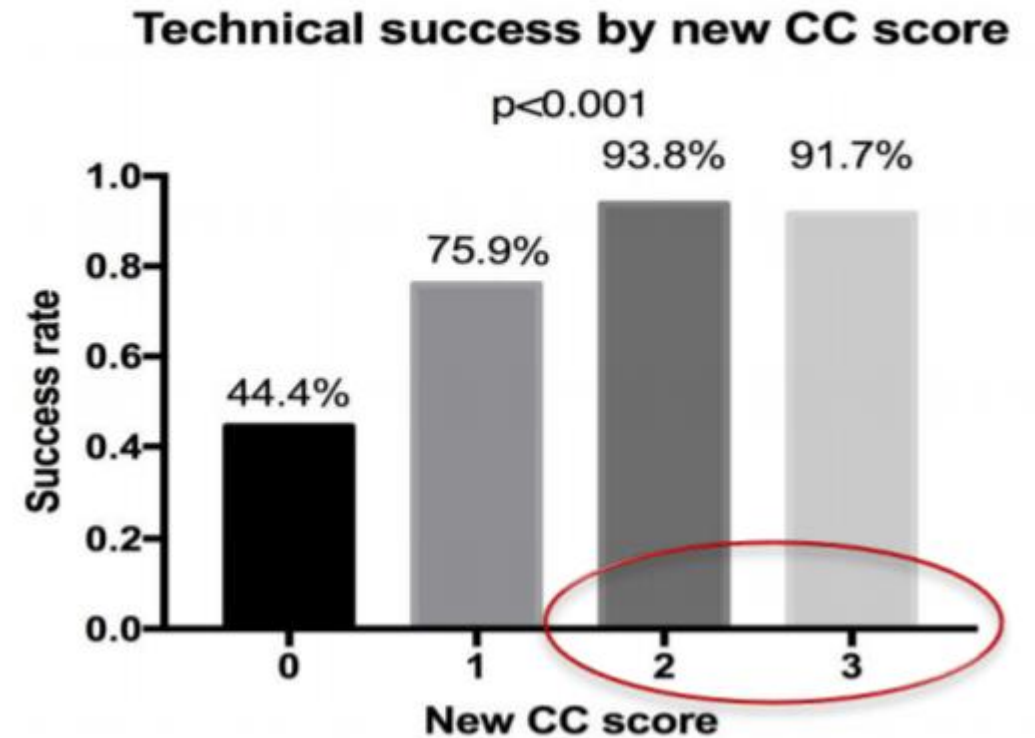
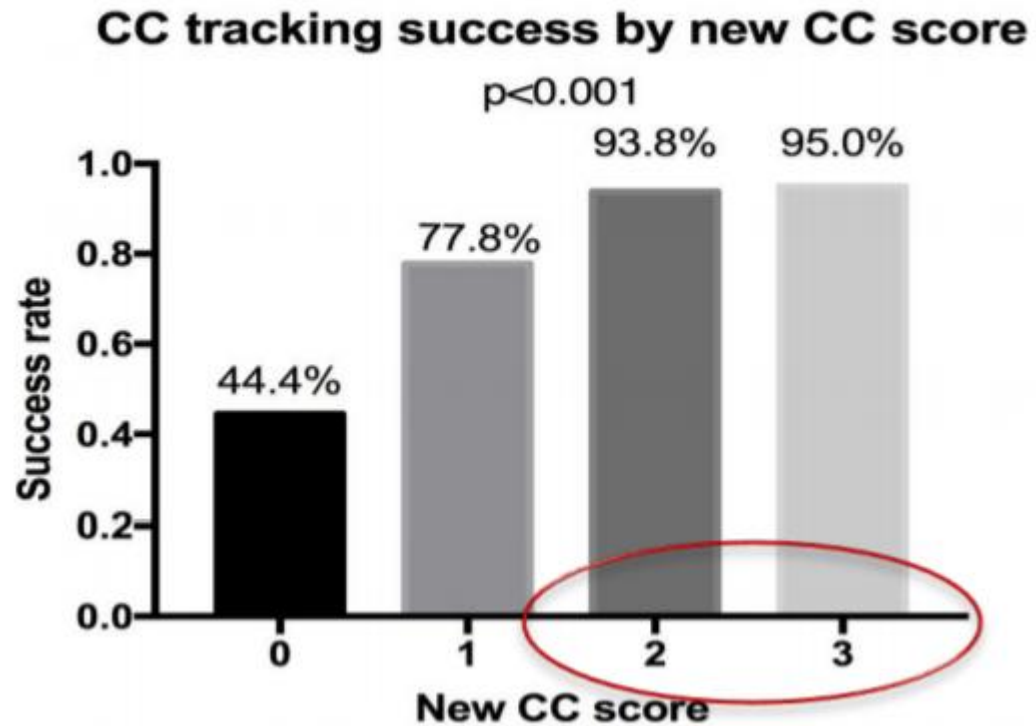
“R Score”

Can be counted individually if multiple ICC

- 1 point : CC2
- 0 points : CC0 or 1
- 2 point : Non-tortuous
- 0 point : Tortuous

R score ≥ 2 predicts ICC tracking/overall success rates of $\geq 90\%$

“R Score”



Preditores falha acessar CC

Table 7. Logistic Regression Analysis Showing Relationship Predictors of Retrograde Failure

Variable	Odds Ratio	95% CI	<i>P</i>
Channel used (epicardial)	0.515	0.28–9.57	0.656
Recipient vessel angle not visible	47.09	1.65–1340.42	0.024
Tortuosity of channel-corkscrew	8.31	1.63–42.36	0.011
CC1	2.16	0.43–10.74	0.346
Previous MI	0.419	0.04–3.81	0.440
In-stent restenosis	1.71	0.22–12.88	0.599
Bridging collaterals	1.09	0.29–4.00	0.896
Significant sidebranch	1.51	0.33–6.72	0.588
Severe tortuosity	0.757	0.11–4.94	0.771
Severe calcification	2.67	0.51–13.93	0.243
Ostial location	1.34	0.22–7.98	0.744
CTO length >20 mm	0.971	0.93–1.01	0.138
Age	1.01	0.96–1.07	0.547
Male sex	1.72	0.33–8.87	0.512

Or CC0

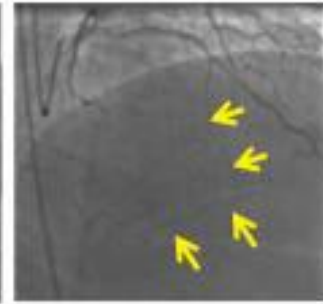
“Collateral Channels”

1. Grafts
2. Septal
3. Epicardial

Bypass graft



Septal



Epicardial



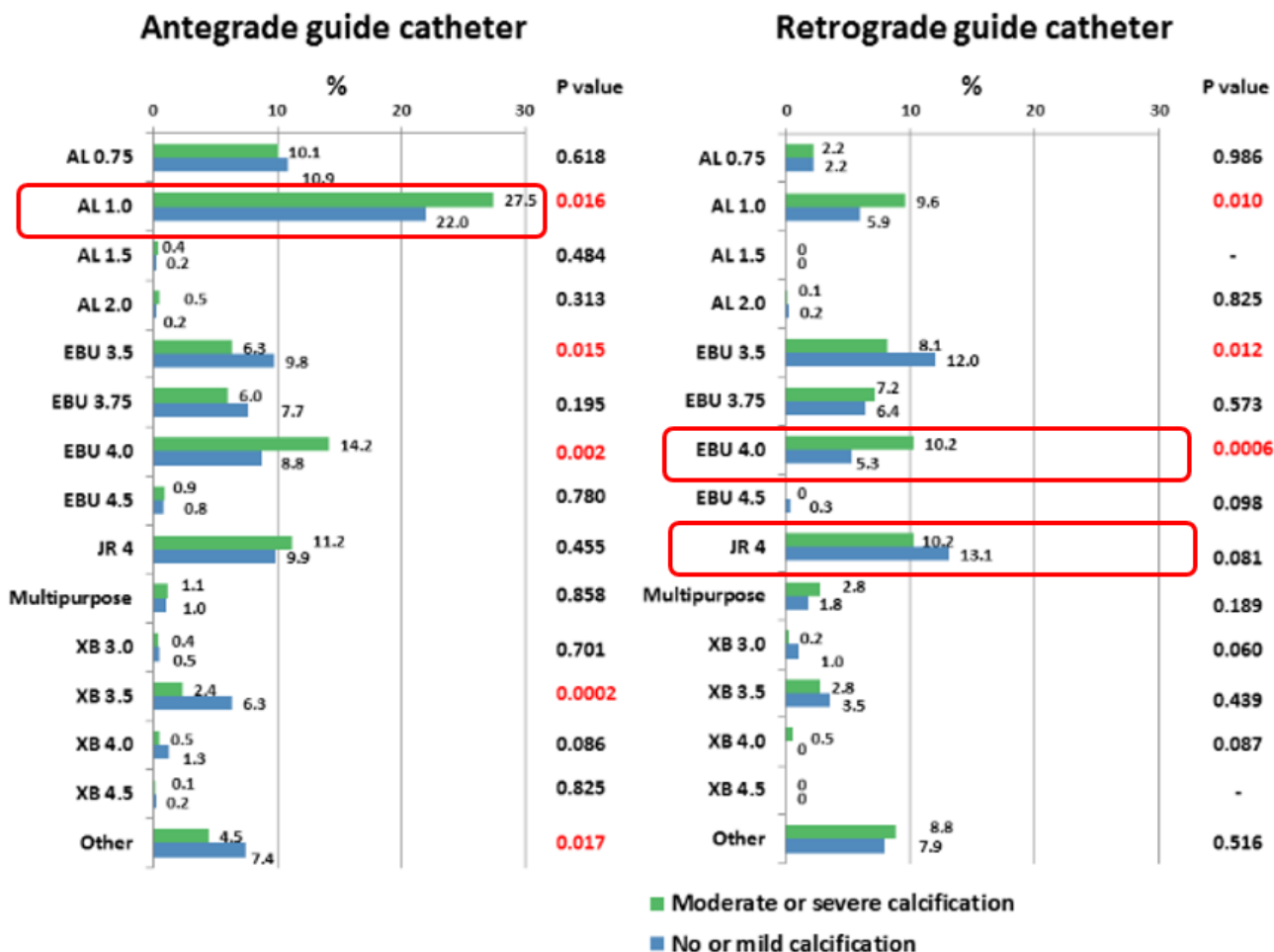
Tortuosity	+	++	+++
Tamponade risk	+	+	+++
Wiring difficulty	+	++	+++
Able to dilate	Yes	Yes	No



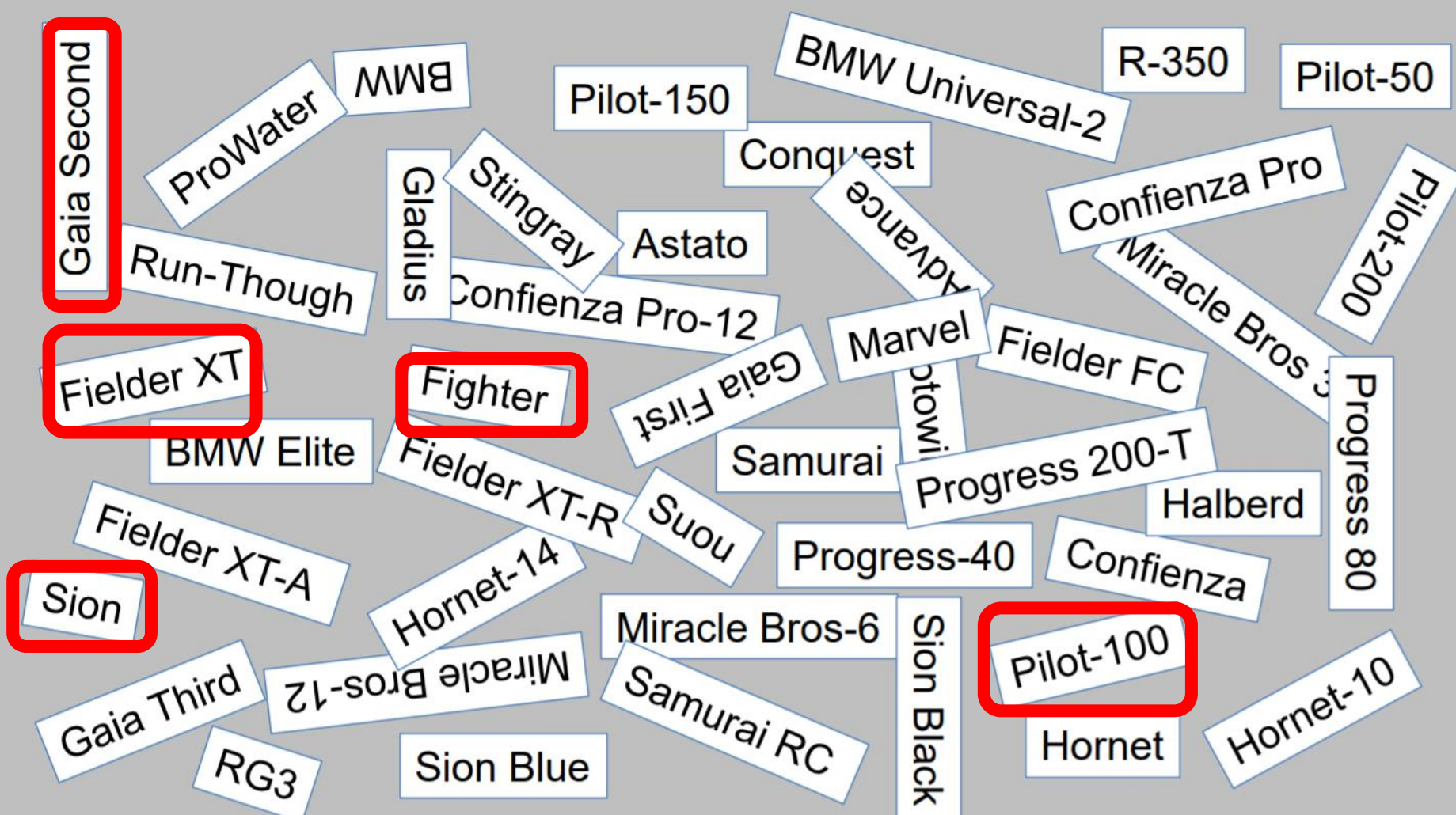
PROspective Global REgiSty for the Study of CTO interventions

www.progresscto.org

Guide catheter utilization in calcification



GuideWire



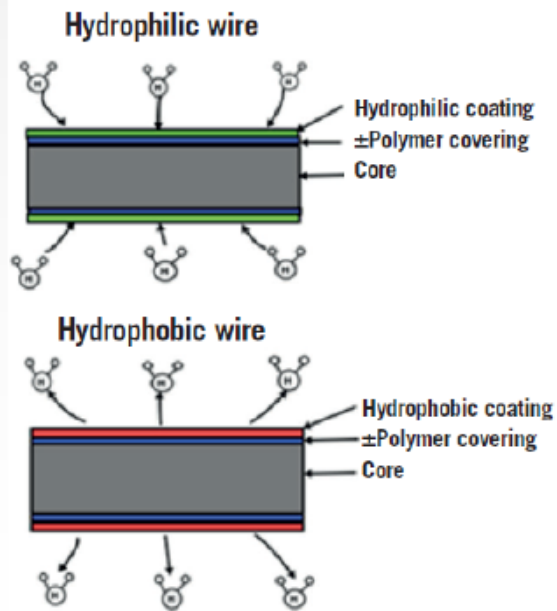
Escolha da Corda Guia

1. O que estou tentando fazer?

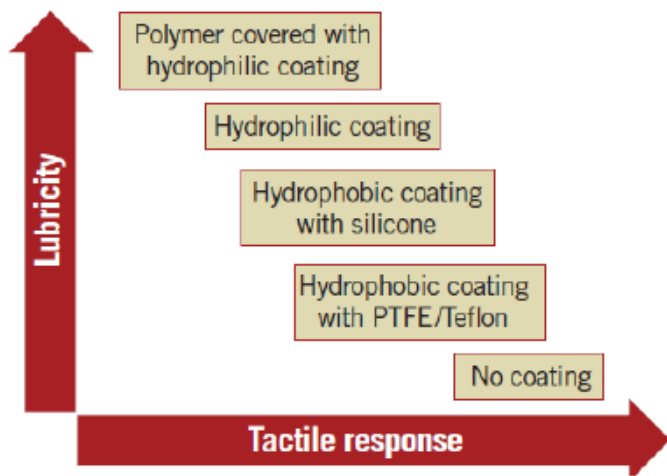
- acesso de rotina ou distal complexo de vaso patente
- penetração dirigida através de tecido oclusivo
- cruzamento de colaterais
- knuckling
- reentrada (anterógrada ou retro)
- externalização

2. Que elementos do fio permitem essa função?

Lubricty and tactile response



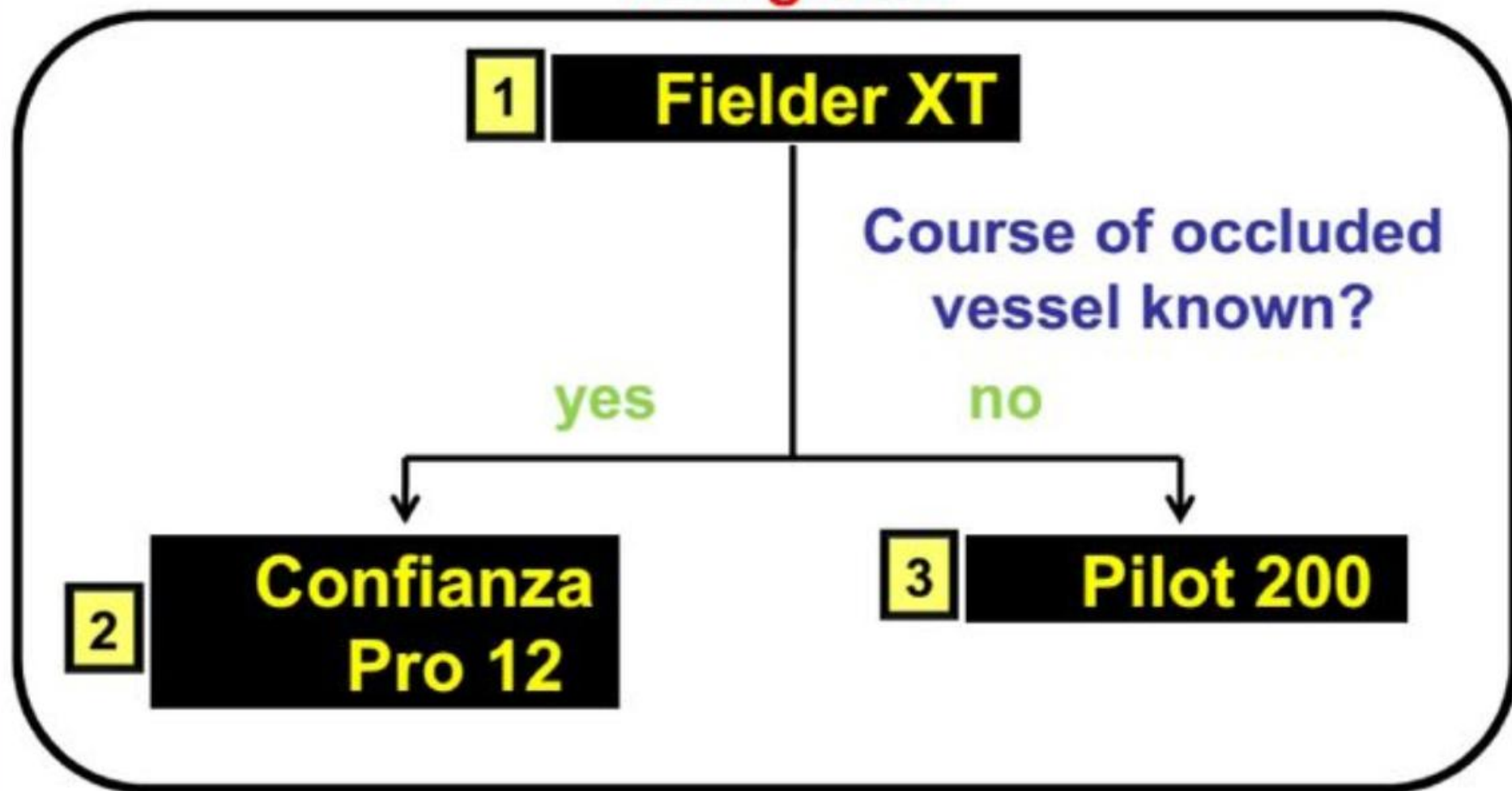
Hydrophilic coatings	Hydrophobic coatings
Attract water	Repel water
Non-slippery solid, becomes low friction, gel-like surface with water	Silicone or Teflon based, wax-like surface



Green. EuroCTO 2016.

Guidewire Selection Simplified

Antegrade



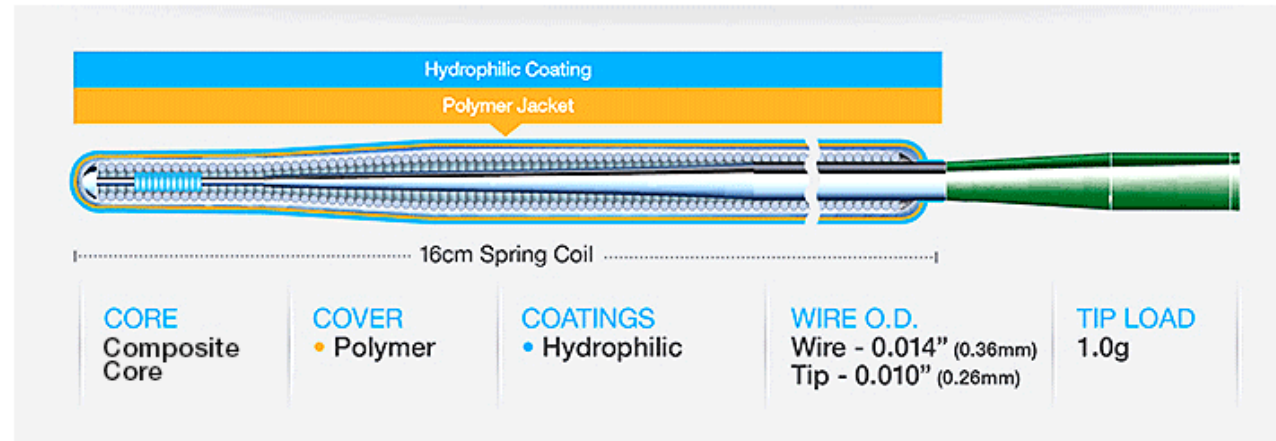
Retrograde

4

Sion

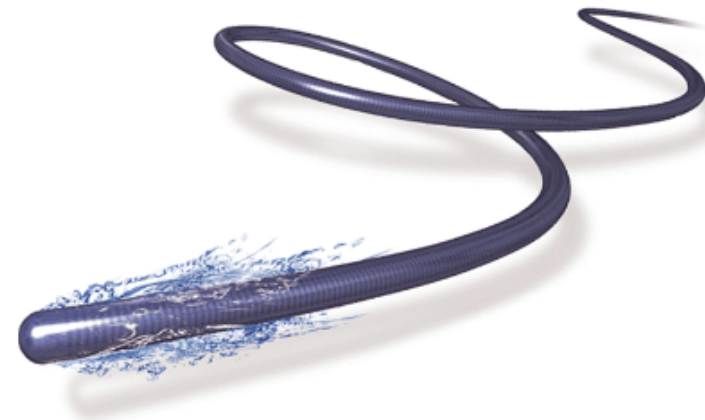
ASAHI Fielder XT-A

Guide wire with a higher tip load than Fielder XT-R, facilitating entry into the chronic occluded lesion.



Features

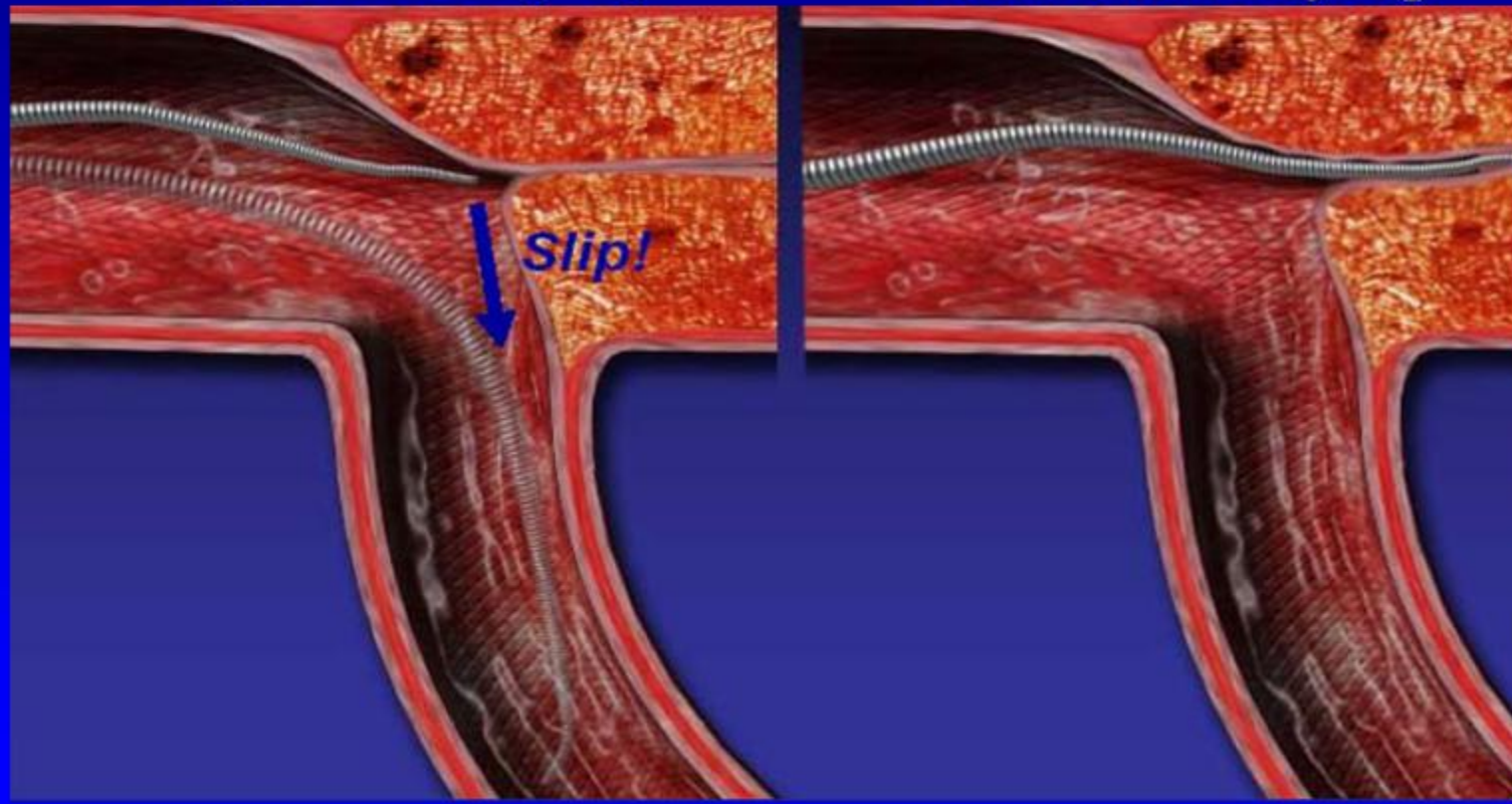
- 0.014" Guide wire
- 0.010" Tapered tip
- 1.0gf Tip load
- 1:1 Torque
- 17cm Polymer jacket
- 17cm Hydrophilic coating
- 16cm Spring coil length
- 16cm Radiopaque segment
- Available in 190cm and 300cm lengths



Hydrophilic vs Hydrophobic GW Tips

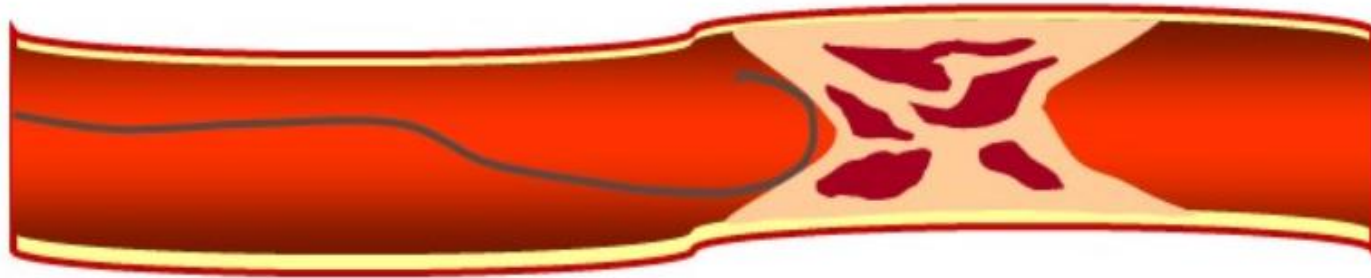
High lubricity tip

Low lubricity tip



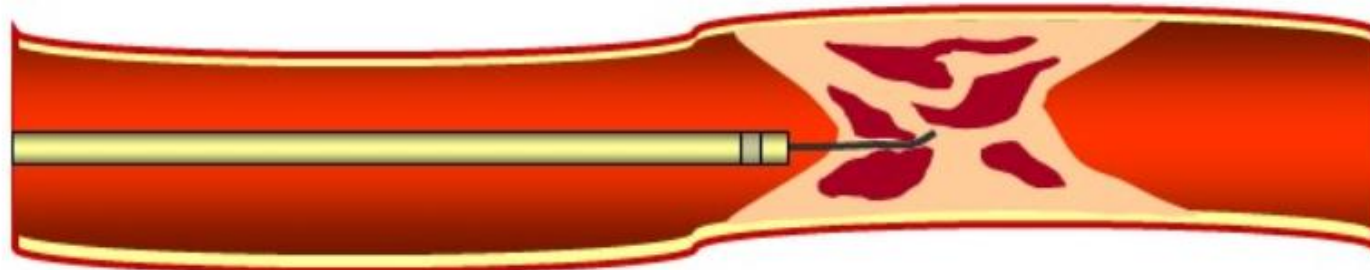
WIRE + MICROCATHETER

Wire only



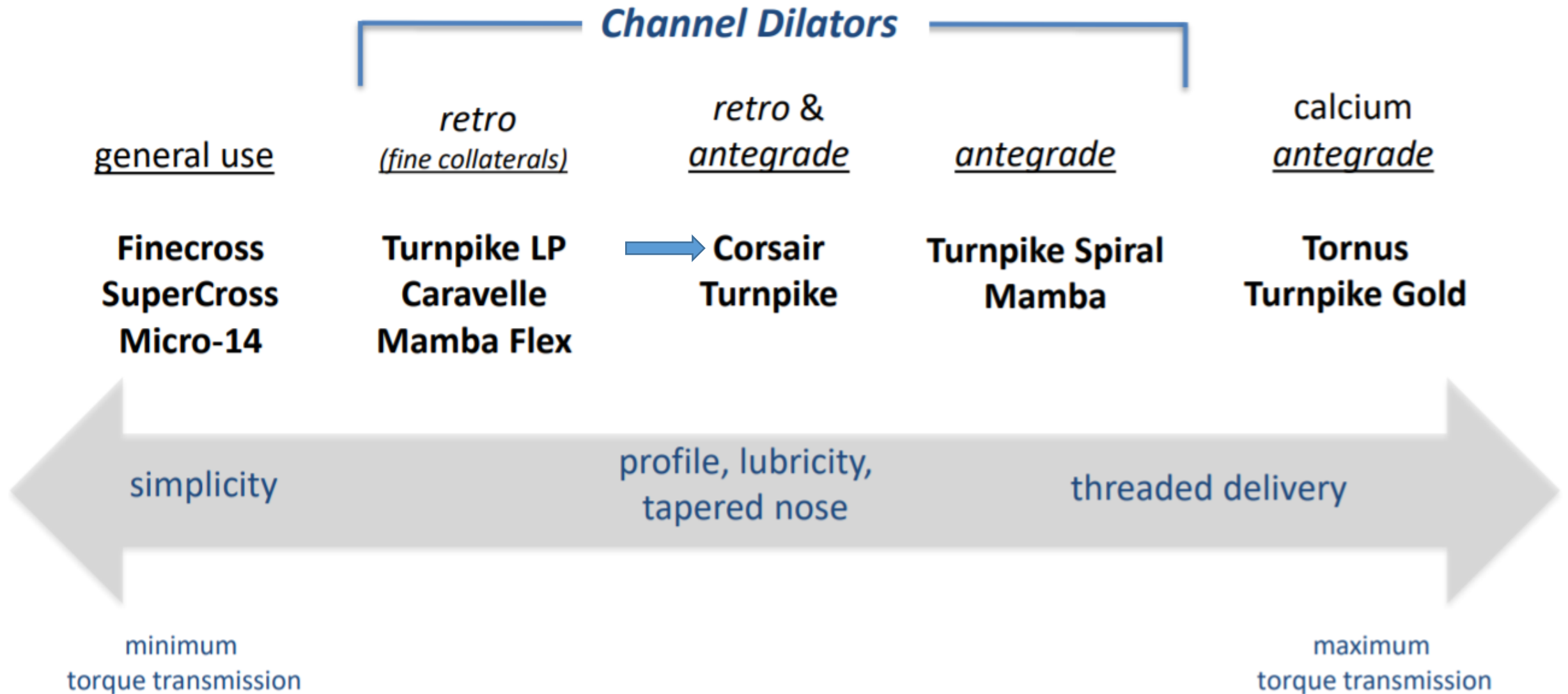
The tip of the guidewire often curves back at the proximal fibrous cap due to poor backup support.

Wire with Micro-catheter



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



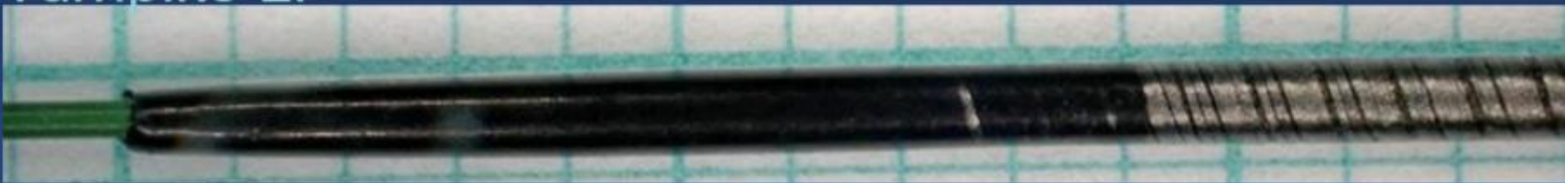

Design Spectrum of Microcatheters

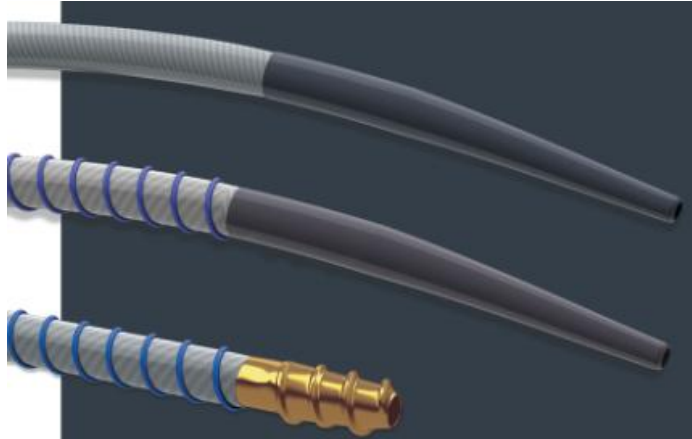


Microcateteres

	Caravel	Finecross	Turnpike LP	Corsair/Corsair Pro	Turnpike
Tip profile	1.4Fr 0.48mm	1.8Fr 0.6mm	1.6Fr 0.53mm	1.3Fr 0.42mm	1.6Fr 0.53mm
Crossing profile	1.9 Fr 0.62mm	1.8Fr 0.6mm	2.2Fr 0.74mm	2.6Fr 0.87mm	2.6Fr 0.86mm
Proximal shaft	2.6Fr 0.85mm	2.6Fr 0.87mm	2.9Fr 0.97mm	2.8Fr 0.93mm	3.1Fr 1.02mm

Microcateretes

1.3Fr .42mm	Corsair  A black microcaterete with a thin, tapered tip and a long, thin, braided metal shaft.
1.4Fr .48mm	Caravel  A black microcaterete with a thin, tapered tip and a long, thin, braided metal shaft.
1.6Fr .53mm	Turnpike LP  A black microcaterete with a thin, tapered tip and a long, thin, braided metal shaft.
2.6Fr .53mm	Turnpike  A black microcaterete with a thin, tapered tip and a long, thin, braided metal shaft.



TURNPIKE® CATHETERS

Multi-layer shaft and dual-layer coil provide the ultimate combination of flexibility and torque response



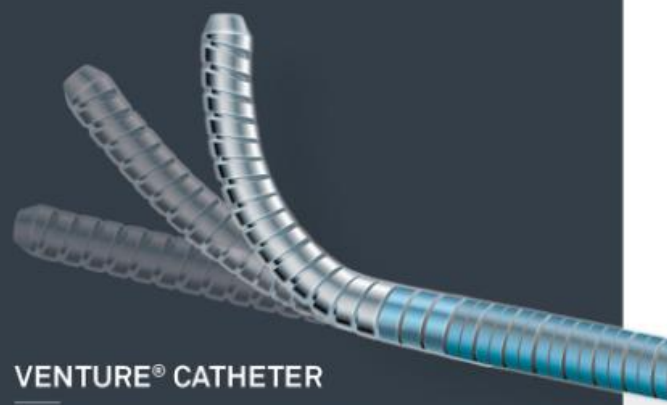
SUPERCROSS™ AT MICROCATHETER

Provides the right support and torque response in tortuous anatomy and navigating bifurcated vessels



TWIN-PASS® DUAL ACCESS CATHETER

Dual lumen design promotes access with rapid exchange convenience for delivery of contrast, medication or a second guidewire



VENTURE® CATHETER

Tip deflects up to 90° to direct guidewires around bends and tortuosity, allowing precision-control during the most challenging interventions



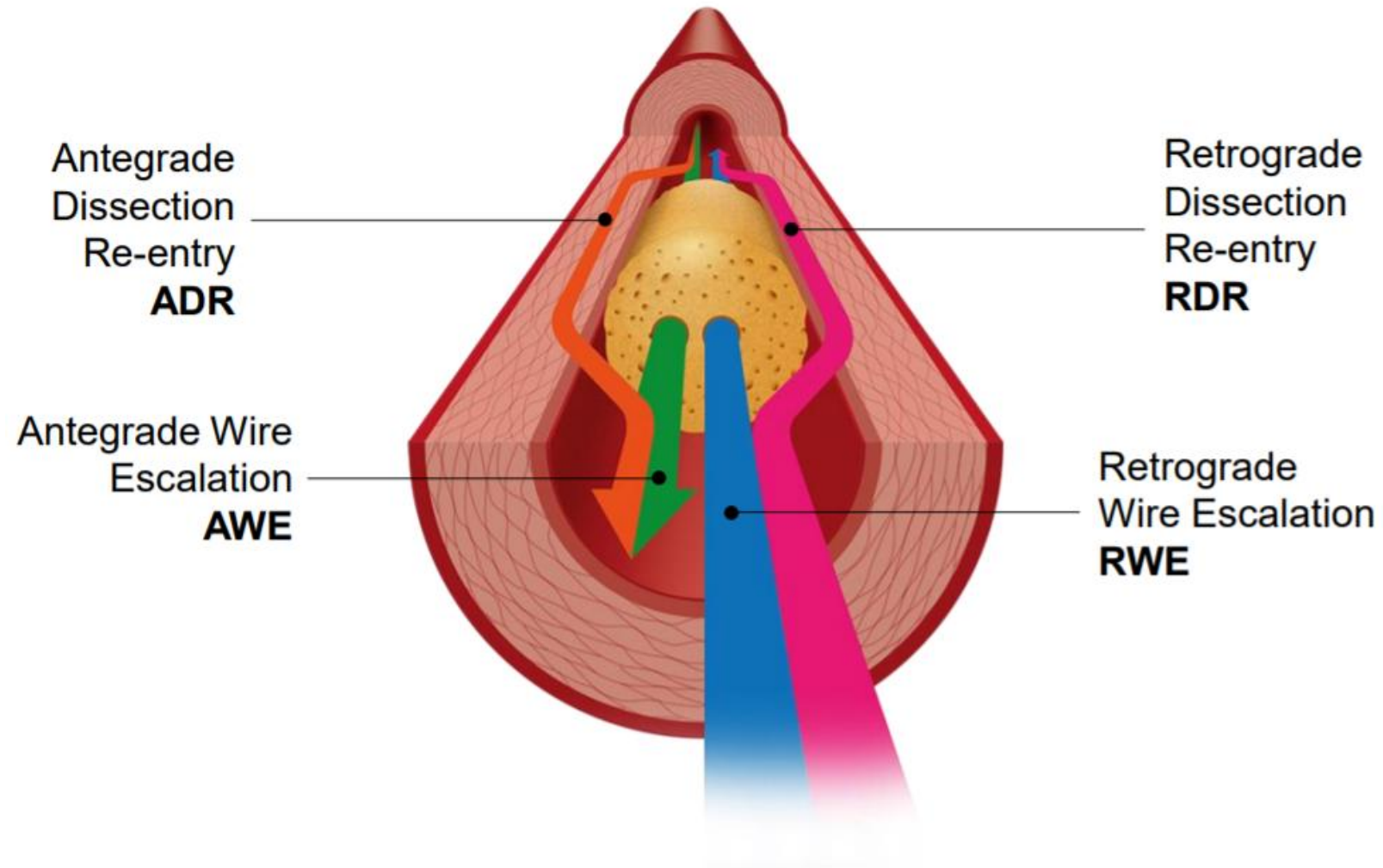
GUIDELINER® CATHETER

Greatly increases backup support and allows deep-seating for coaxial alignment, distal device delivery and selective delivery of contrast

Algoritmo ou Abordagem híbrida

- **2 caminhos:** anterógrado e retrógrado
- **2 maneiras de cruzar CTO:** pelo lúmen verdadeiro ou pelo espaço subintimal (com dissecação e posterior reentrada ao lúmen verdadeiro).
- **4 fatores anatômicos principais:** 1) anatomia da capa proximal
- 2) comprimento da oclusão
- 3) presença de uma zona sem doença para reentrada no vaso distal
- 4) presença de colaterais septais ou epicárdicas utilizáveis.

Técnicas



Técnicas

Anterogrado

- Wire escalation
- Parallel wiring
- STAR/ Mini STAR
(Subintimal Tracking And Re-entry)
- Knuckle

Retrogrado

- CART
(Controlled antegrade and retrograde subintimal tracking)
- Reverse CART
- Knuckle
- Ping Pong
- Rendezvous

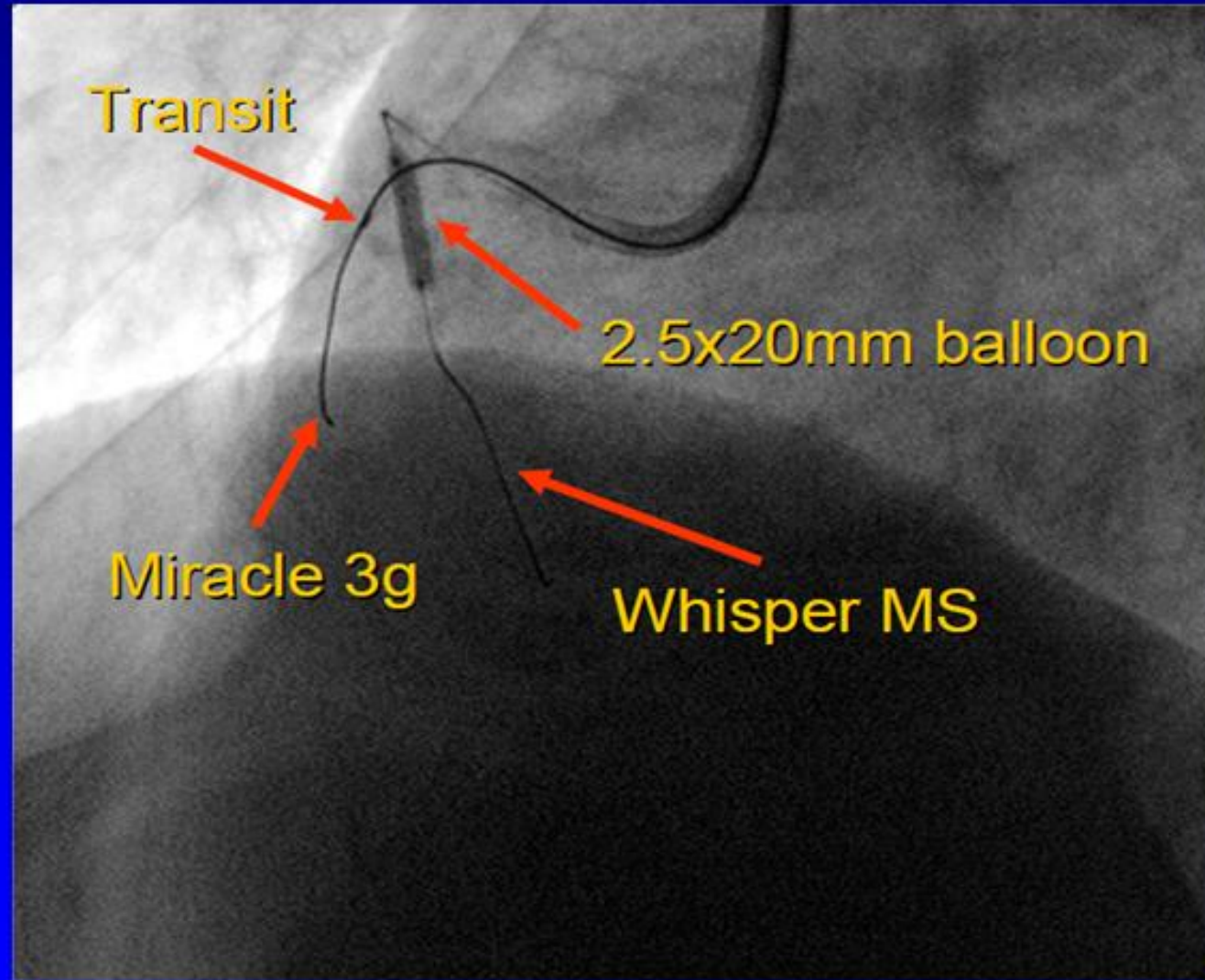
Técnica anterógrada com escalonamento de fios

- Inicia-se com um fio guia de ponta macia (1,0 g) e afilada, revestido de polímero.
- Se não houver êxito no cruzamento, é usado um fio com ponta um pouco mais pesada (4,0 g), também revestido de polímero ou um fio rígido, afilado e com ponta de 12 g.

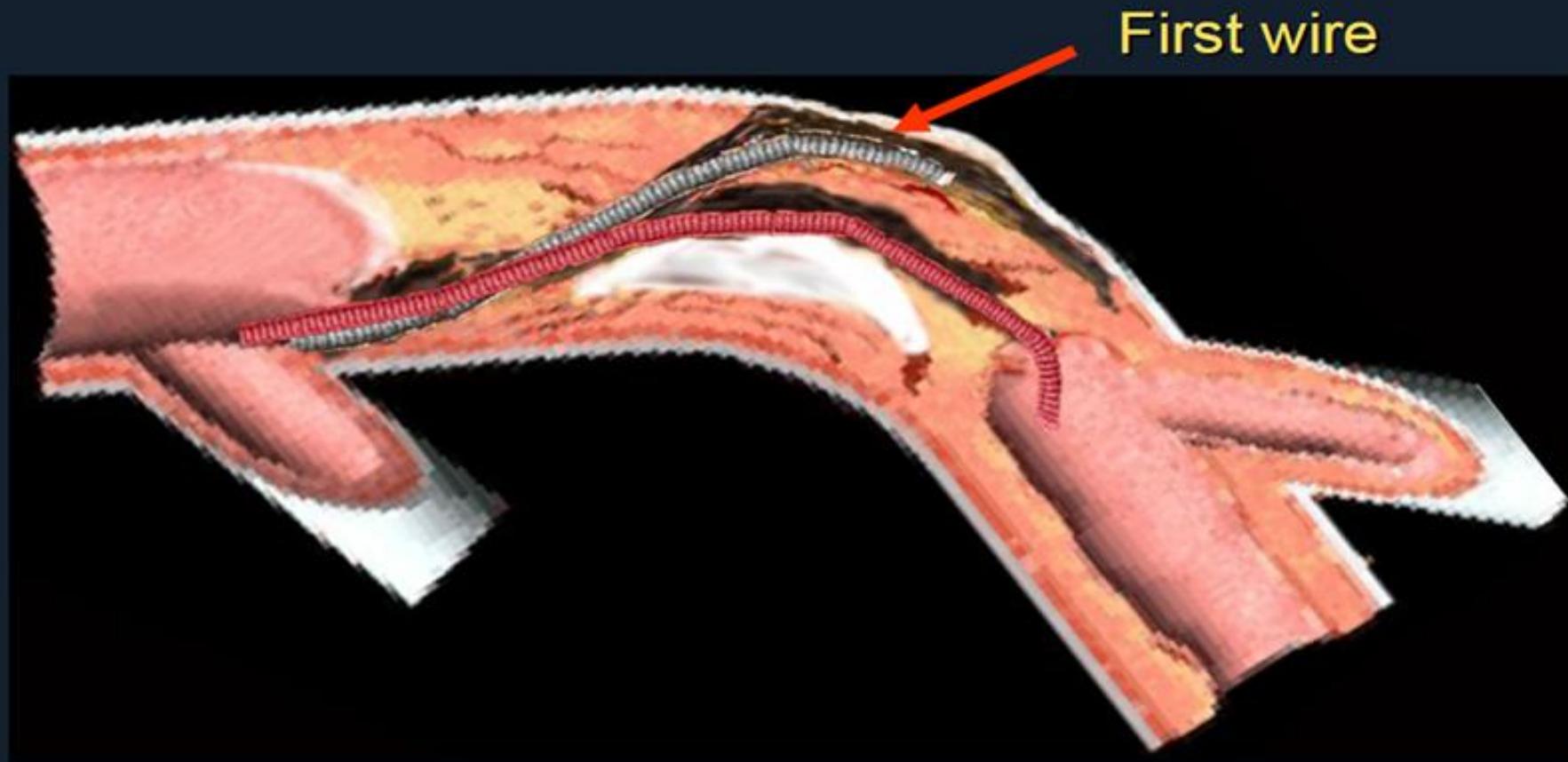
Antegrade technique

- **Always perform dual injections**
- **Always use microcatheter, advancing to the point of CTO over workhorse wire**
- **Wire escalation**
 - Polimer-jacketed wire (Fielder XT)
 - Intermediate wire (Pilot, Gaia)
 - Penetration wire (Confianza 12, Hornet 14)
- **Cross the CTO, change wire to support or workhorse wire, dilate with very low profile balloons**

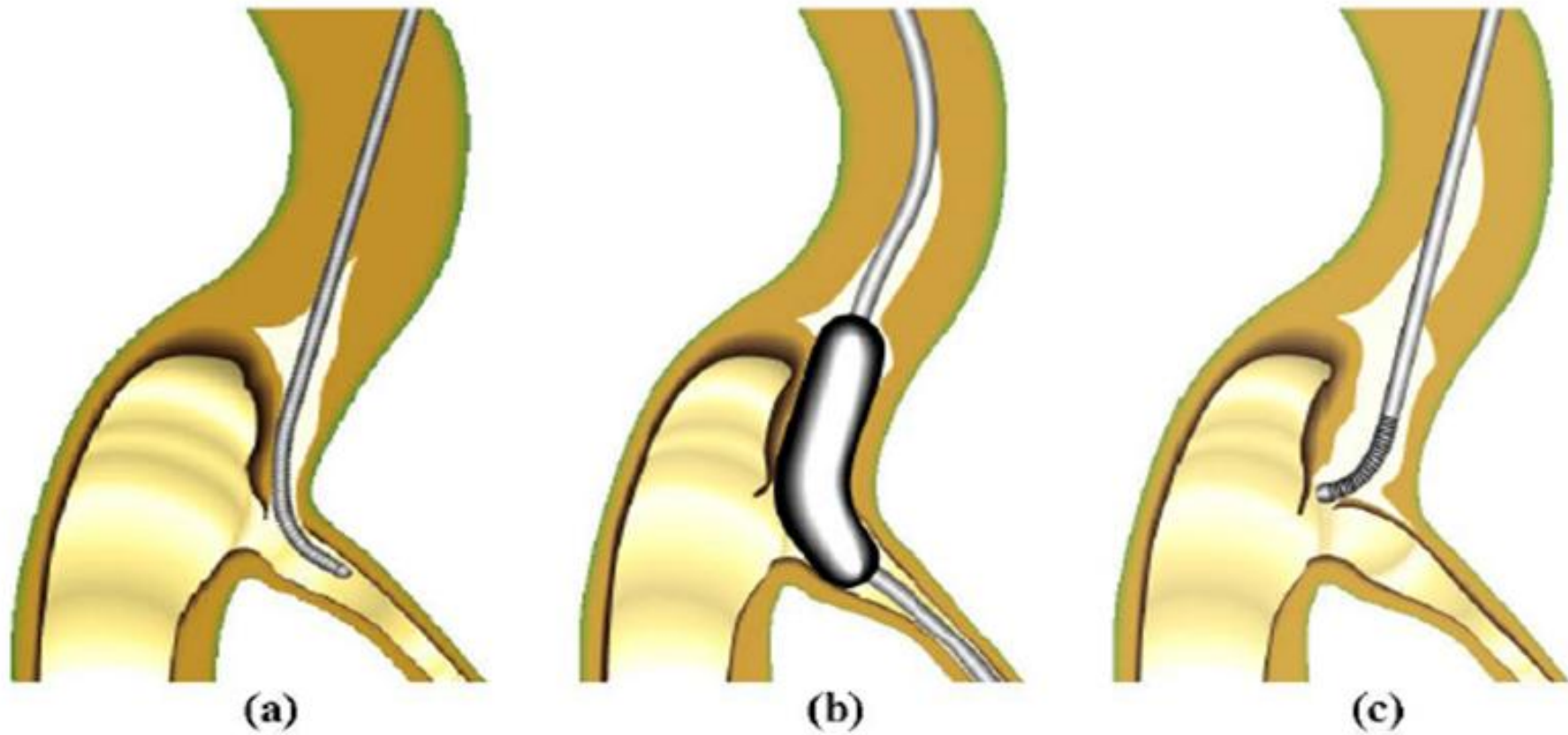
Anchor Technique



Parallel Wire Technique



Side Branch Technique



STAR:

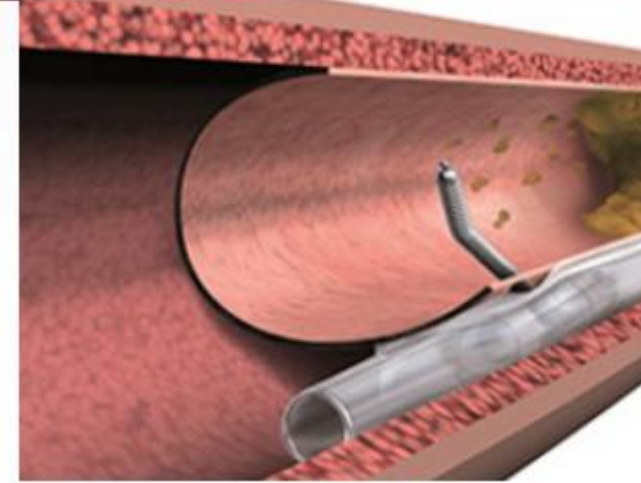
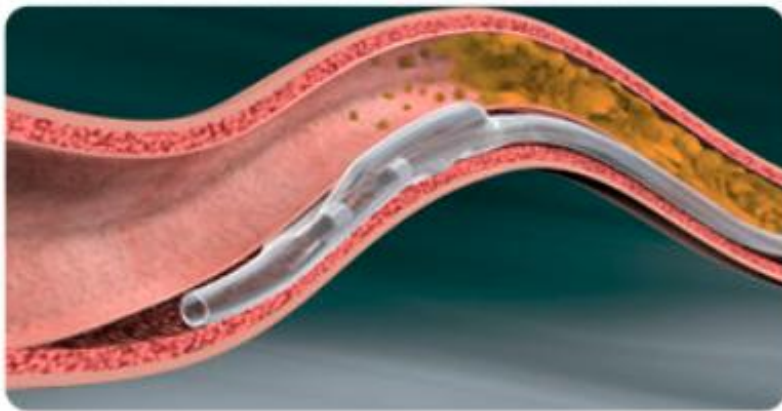
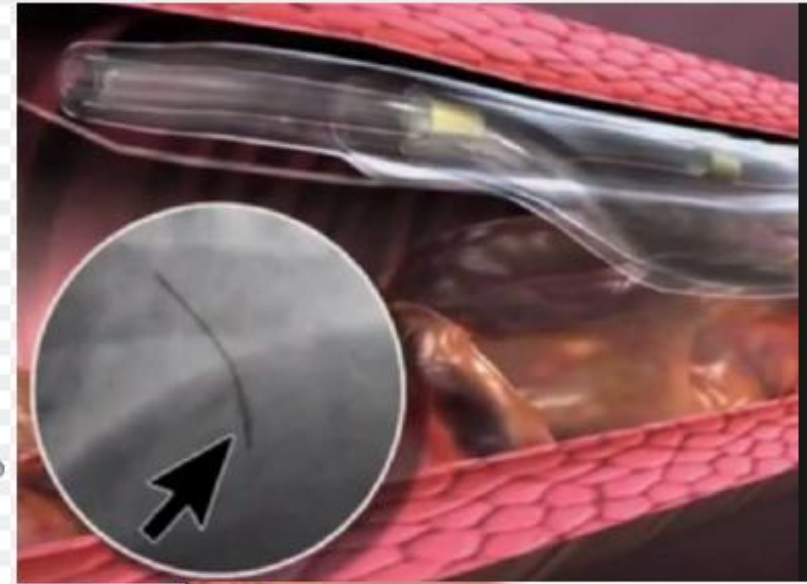
- Create a (long) dissection plane with a hydrophilic wire eg Whisper or Pilot with an “umbrella” handle tip
- Advance the wire whilst maintaining the loop
- 1.5mm OTW balloon for support
- Best suited to the RCA with few proximal branches



ADR – Knuckle wire technique



ADR – Stingray Balloon

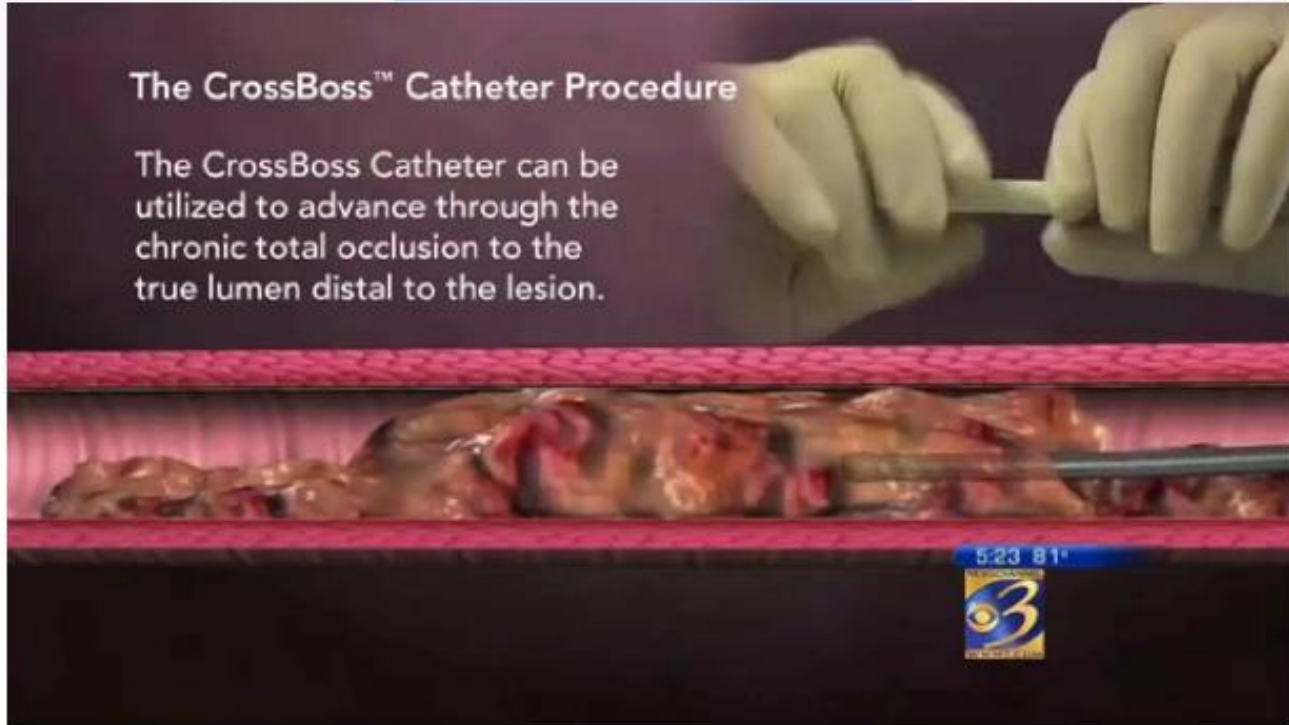


ADR – Crossboss Device

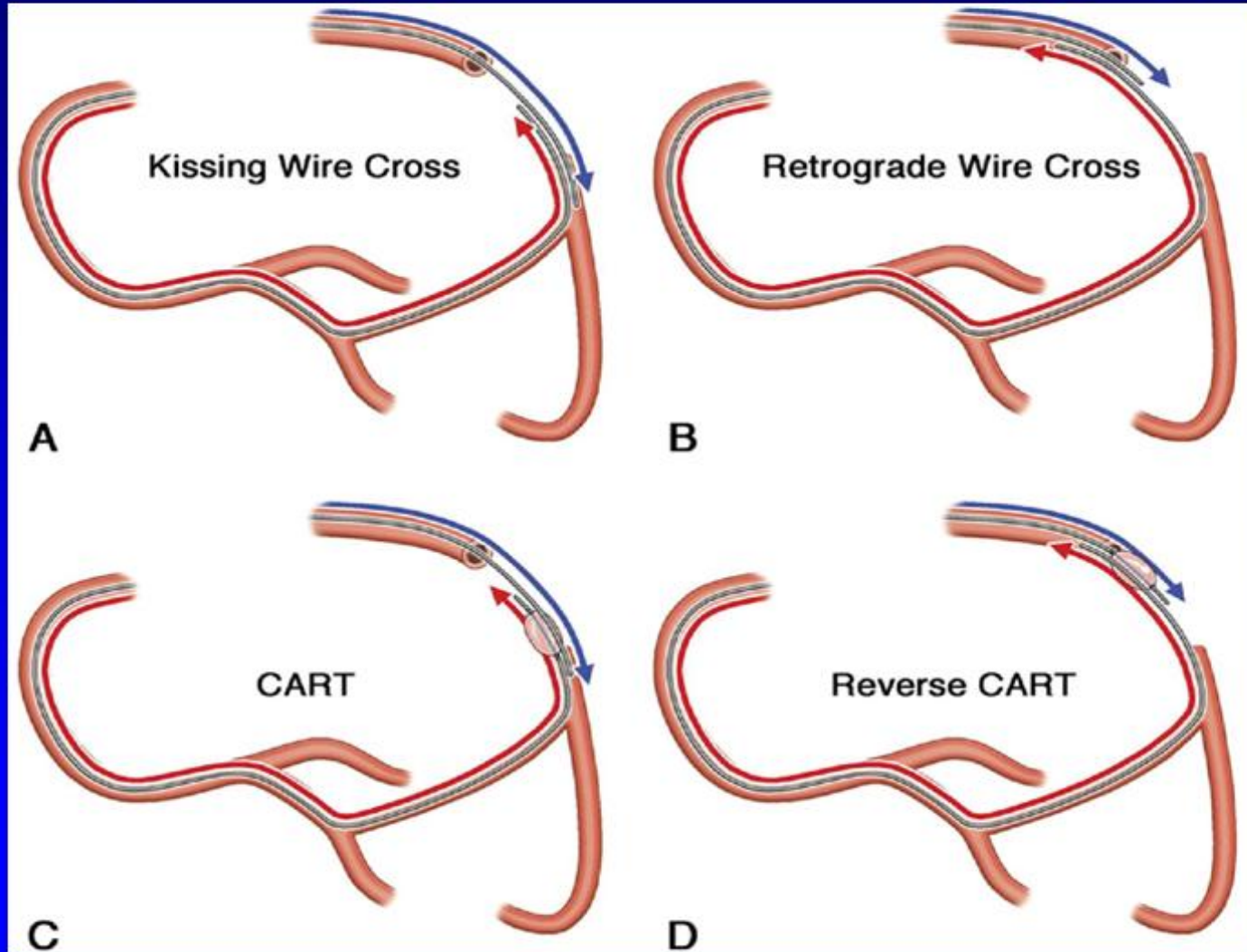


The CrossBoss™ Catheter Procedure

The CrossBoss Catheter can be utilized to advance through the chronic total occlusion to the true lumen distal to the lesion.

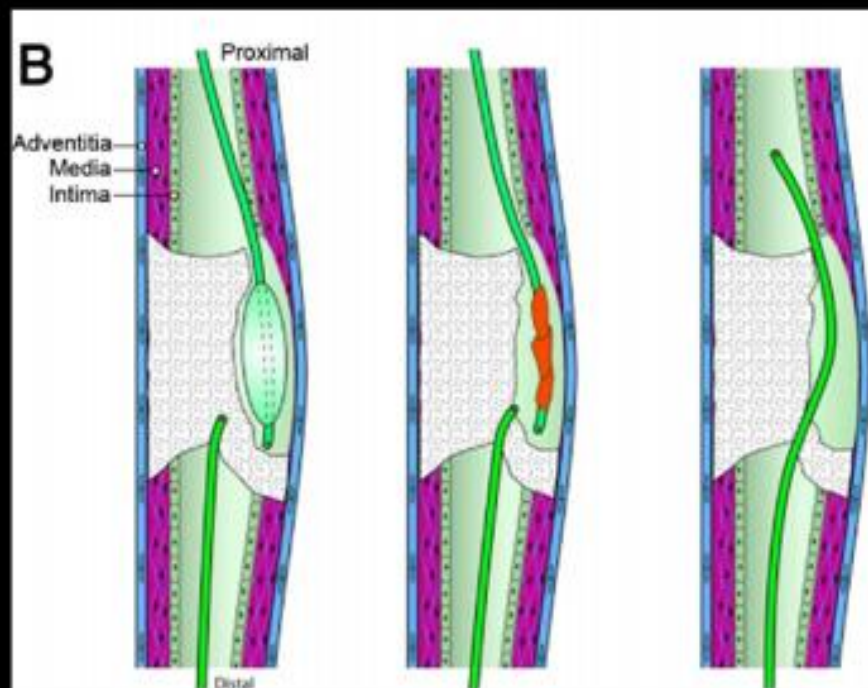
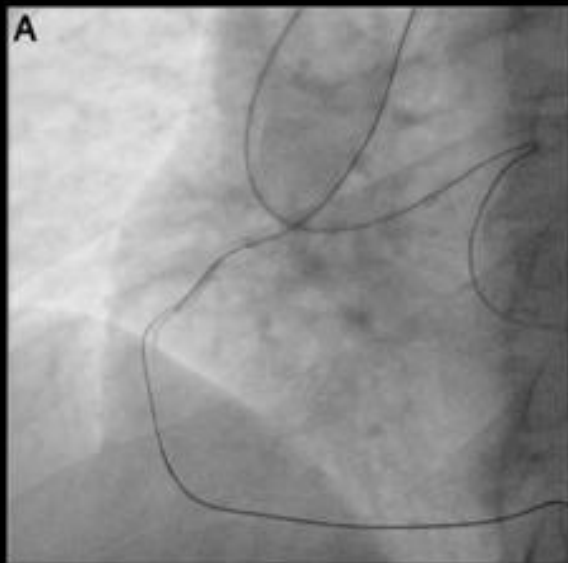


Retrograde CTO Guidewire Techniques

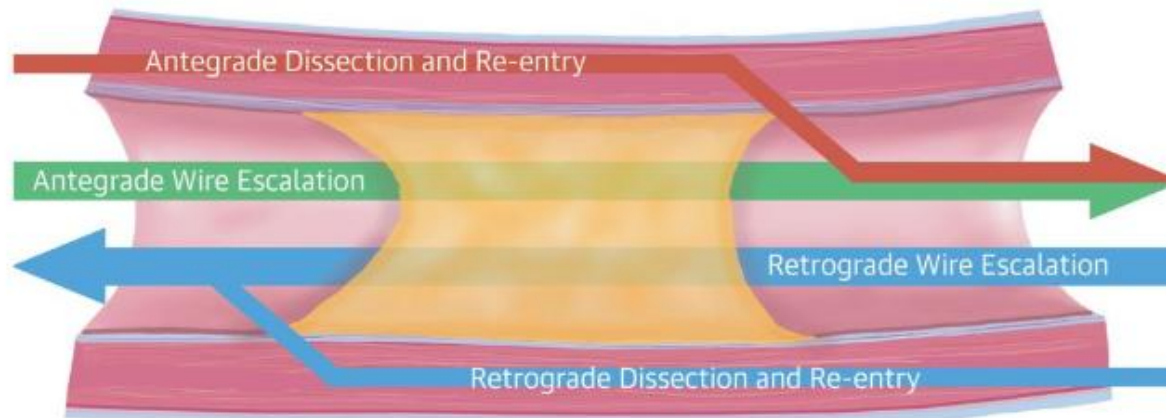


Reverse CART?

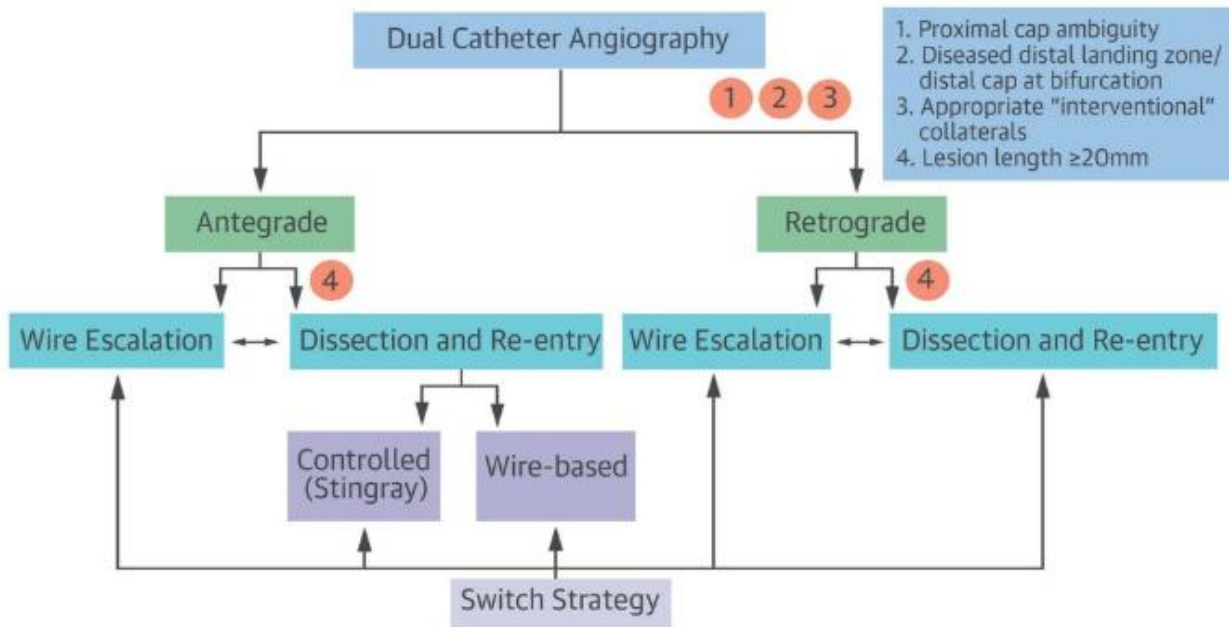
(Controlled Antegrade Retrograde Subintimal Tracking – reverse)



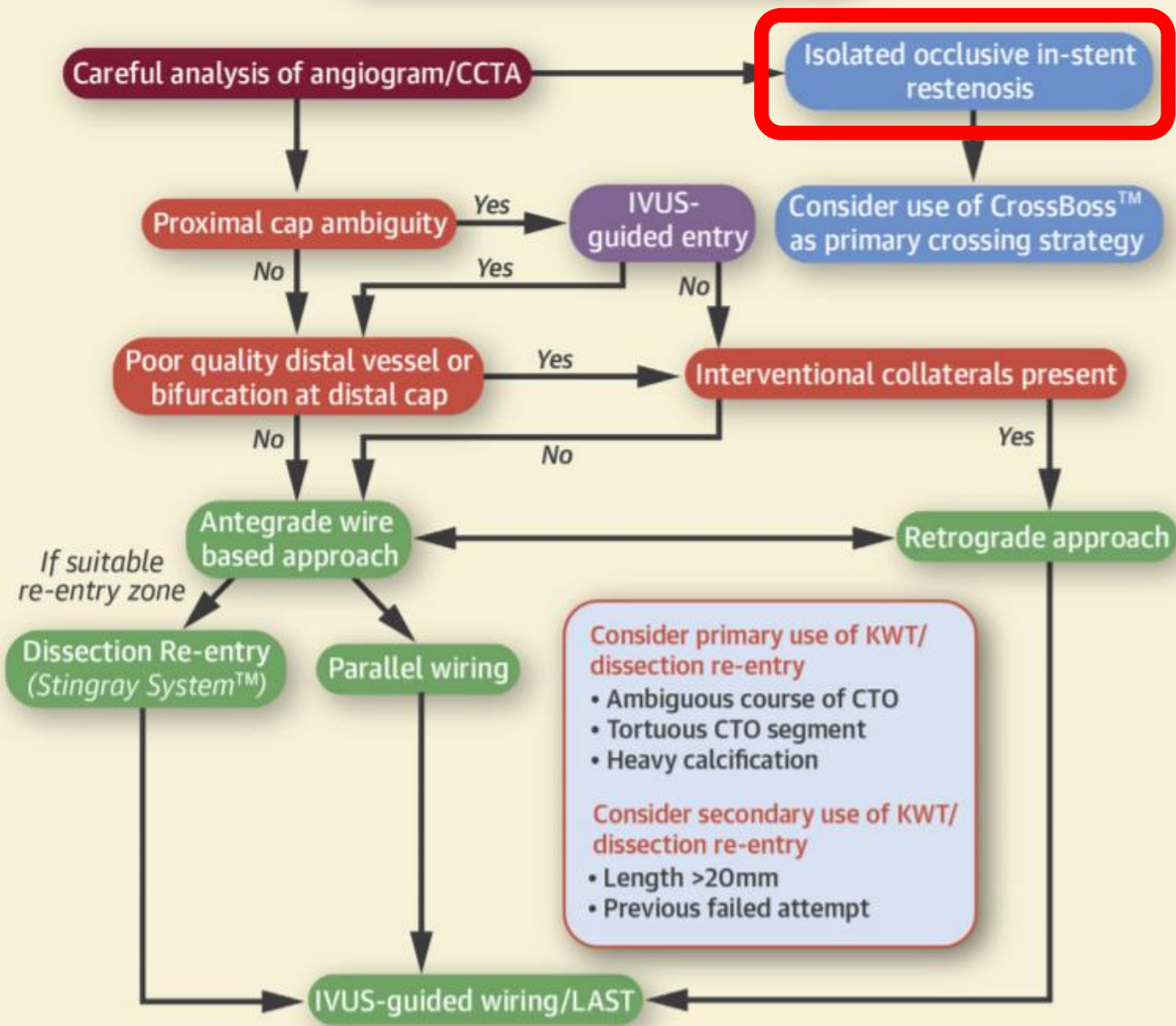
A. The 4 Hybrid Strategies Applied in CTO-PCI



B. The Hybrid Algorithm for CTO Crossing

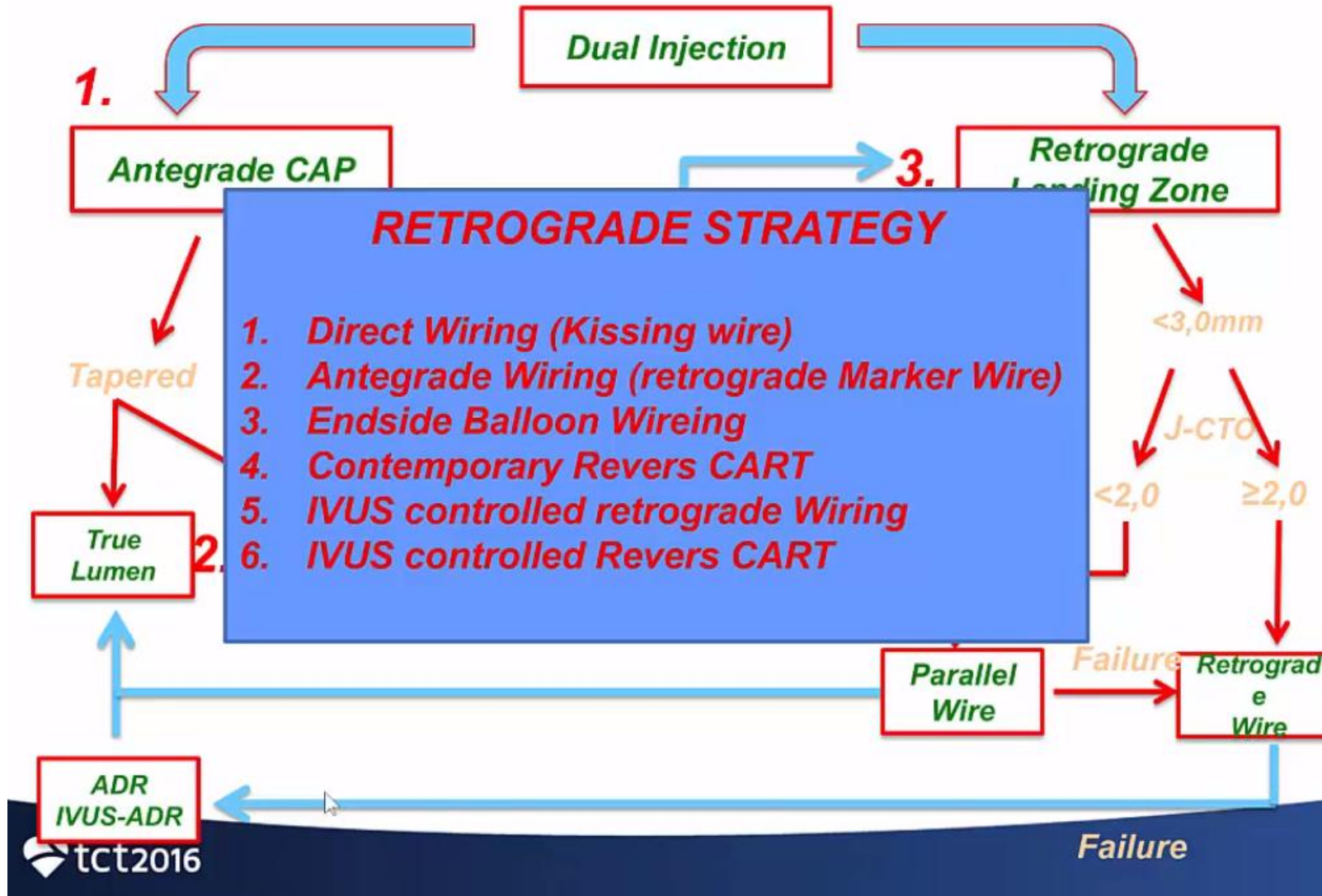


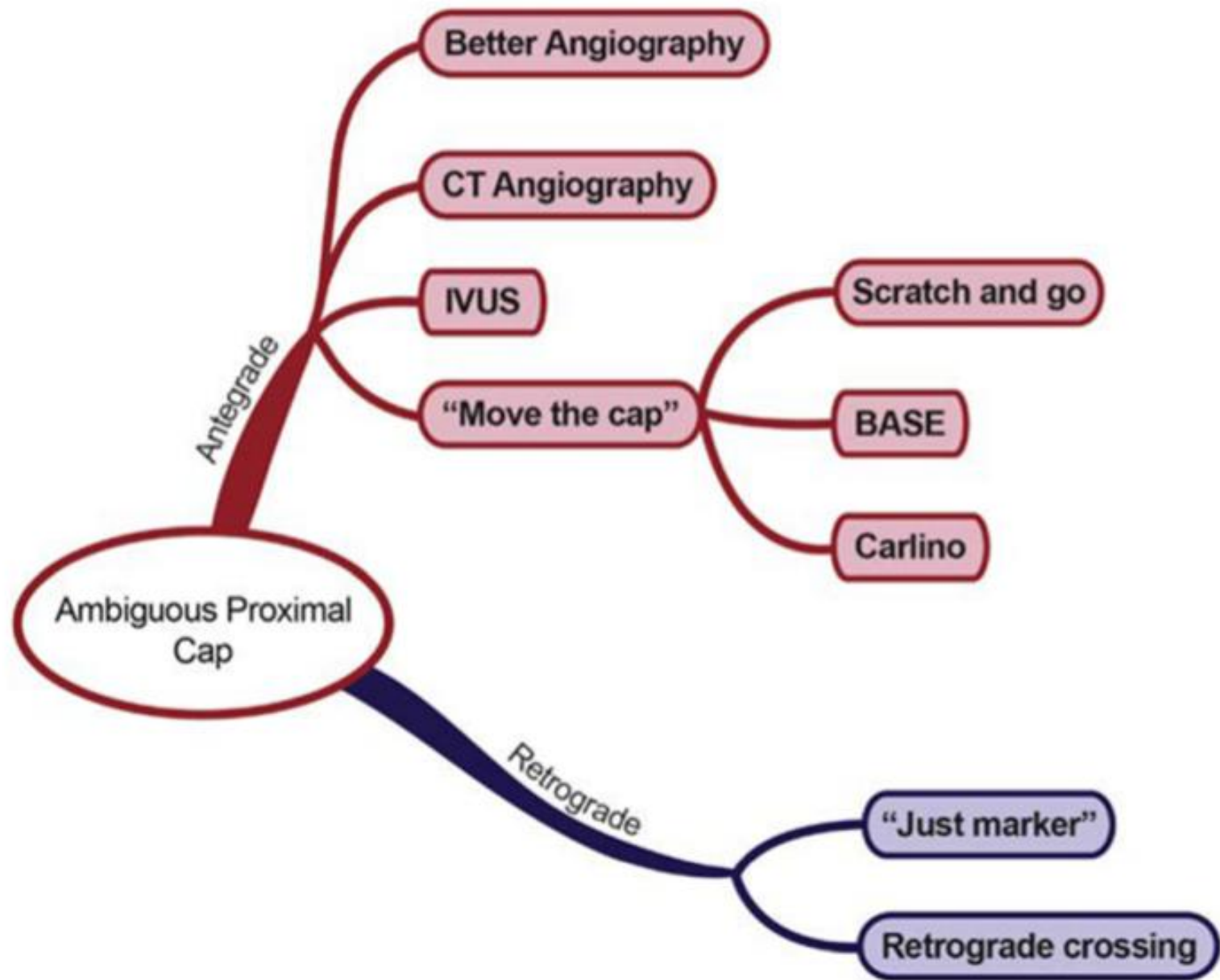
Algorithm for CTO Crossing



Consider stopping if >3 hours, >3.7 x eGFR ml contrast, Air Kerma >5 Gy unless procedure well advanced

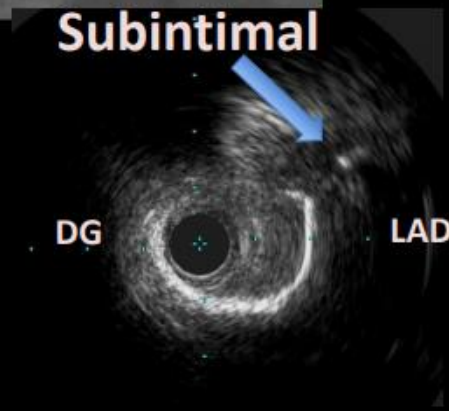
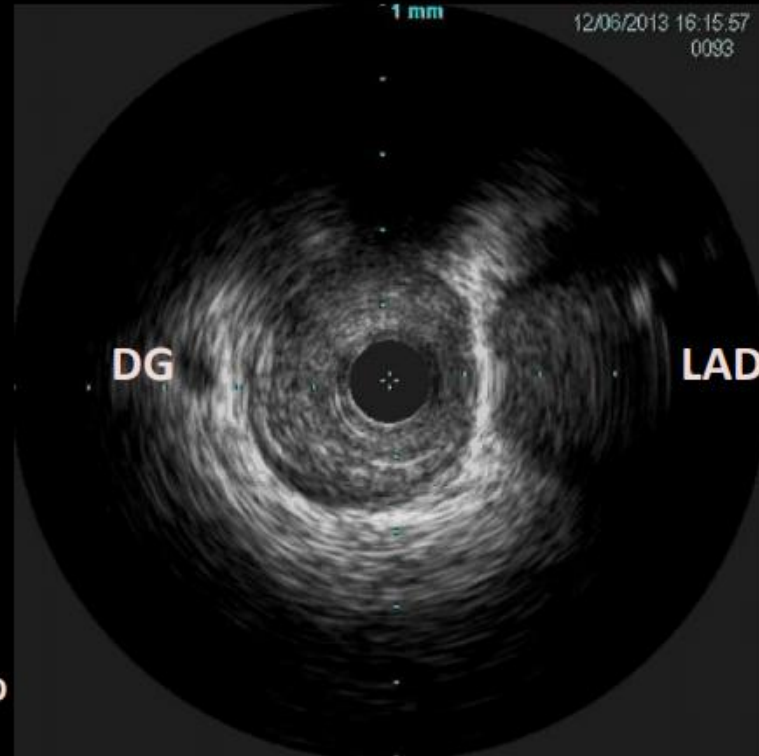
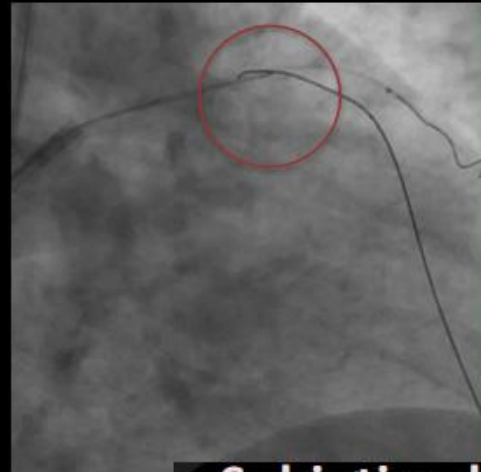
CTO-Strategy:retrograde Approach





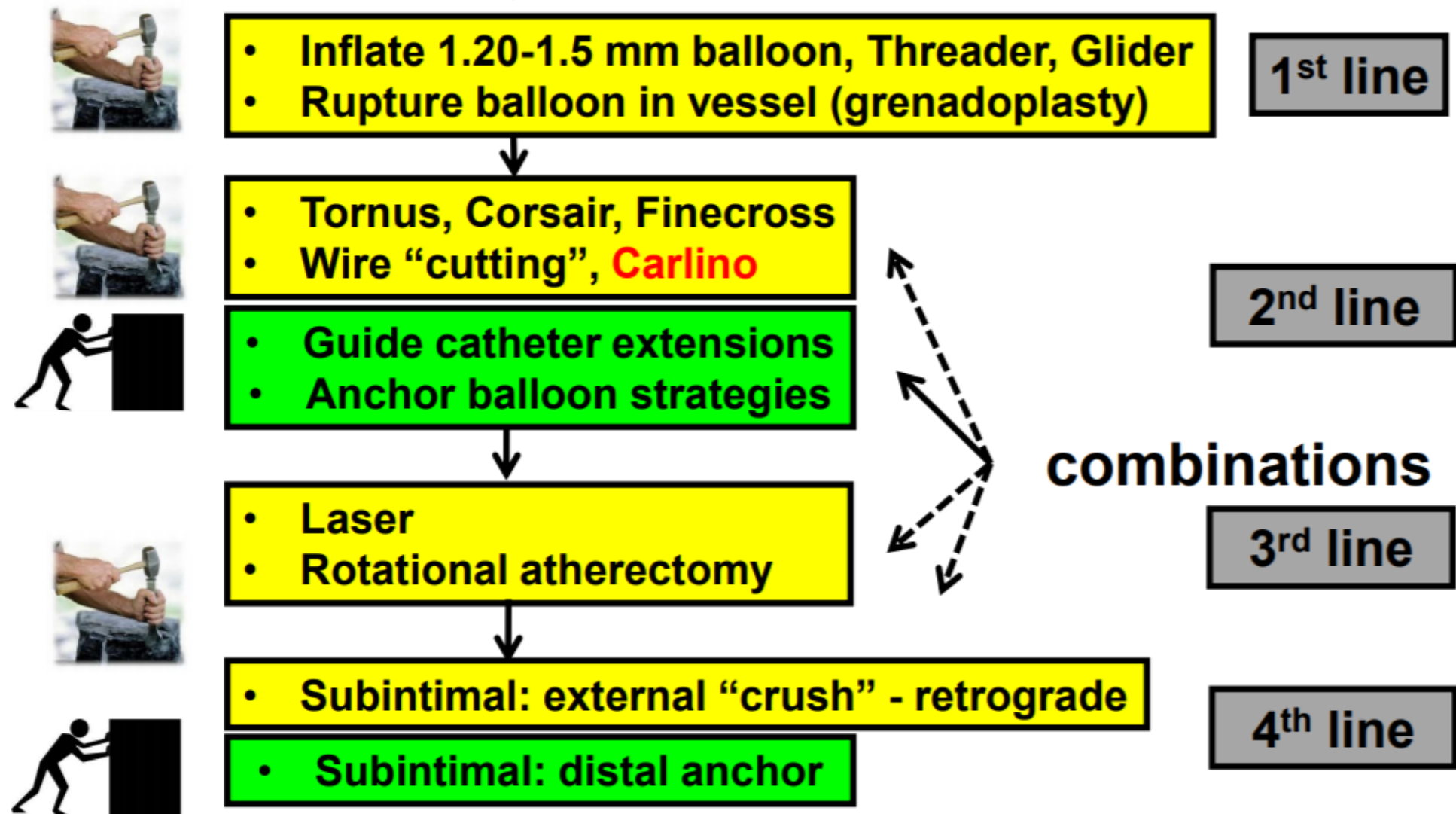
IVUS

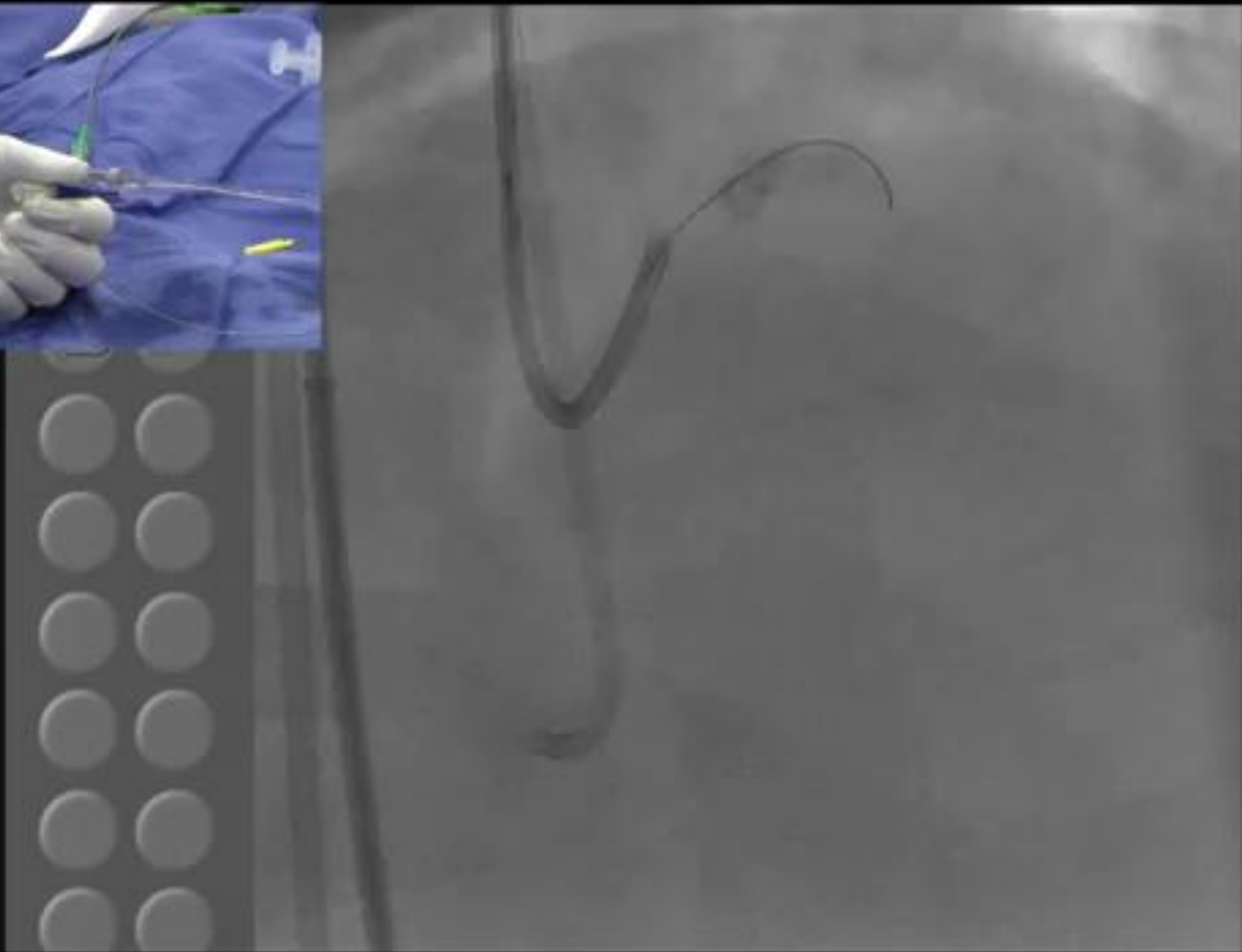
IVUS catheter at bifurcation



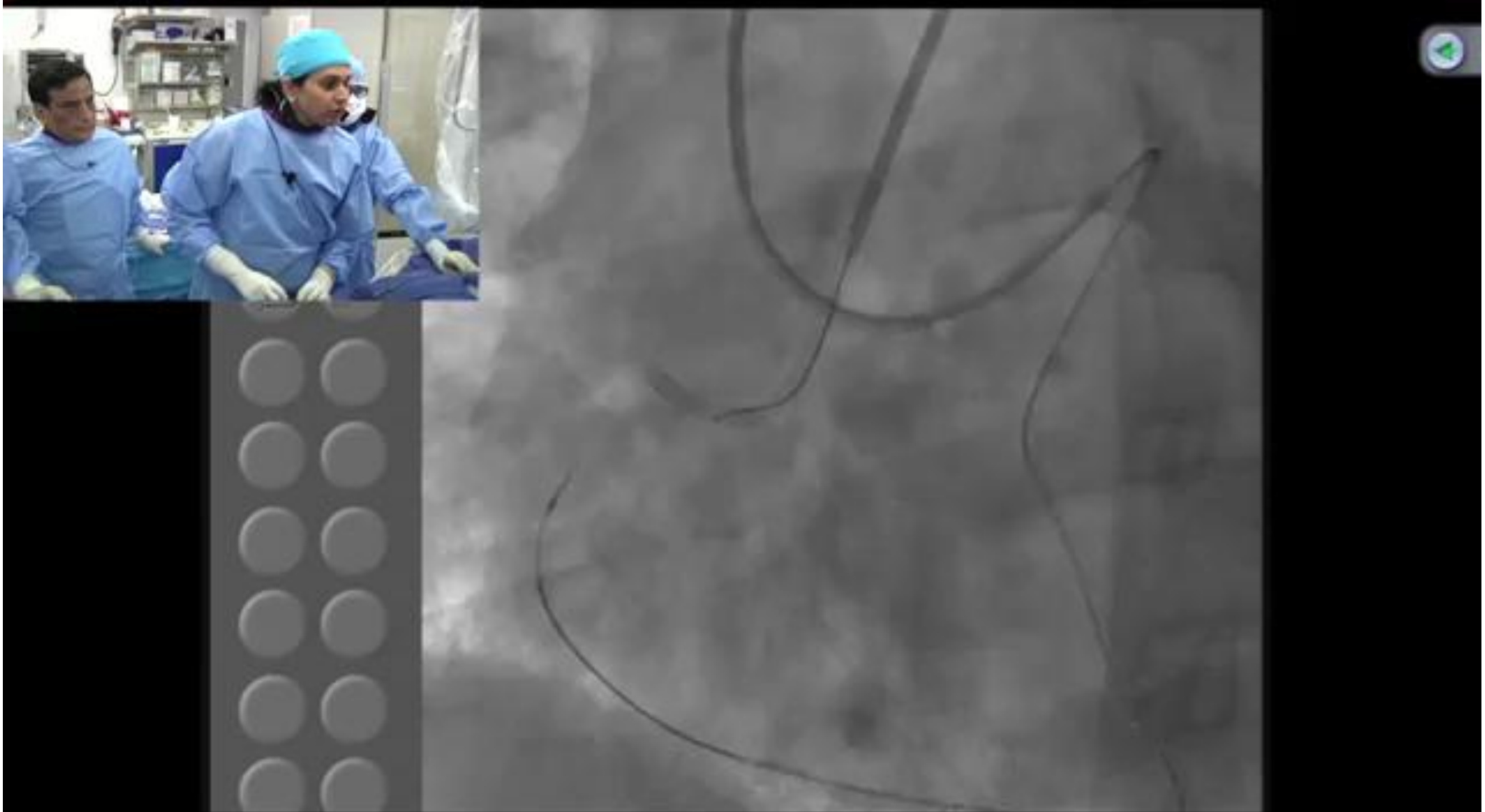
Approach to “balloon uncrossable” CTO

“Balloon Uncrossable” CTO





Guias Externalização



Riscos Externalização e Manejo das Complicações

	RISK	RESULT	MANAGEMENT
1.	Tension on the coronaries	Precipitating ischemia and angina	Careful manipulation of externalized wire
2.	Deep seating of the guide catheters (retro>antegrade)	Guide catheter induced donor vessel dissection	Never Pull gear without careful evaluation under fluoroscopy
3.	Loss of proximal end of wire into Corsair	Uncomfortable feeling of losing wire	Clamp hemostat on proximal end of wire on table

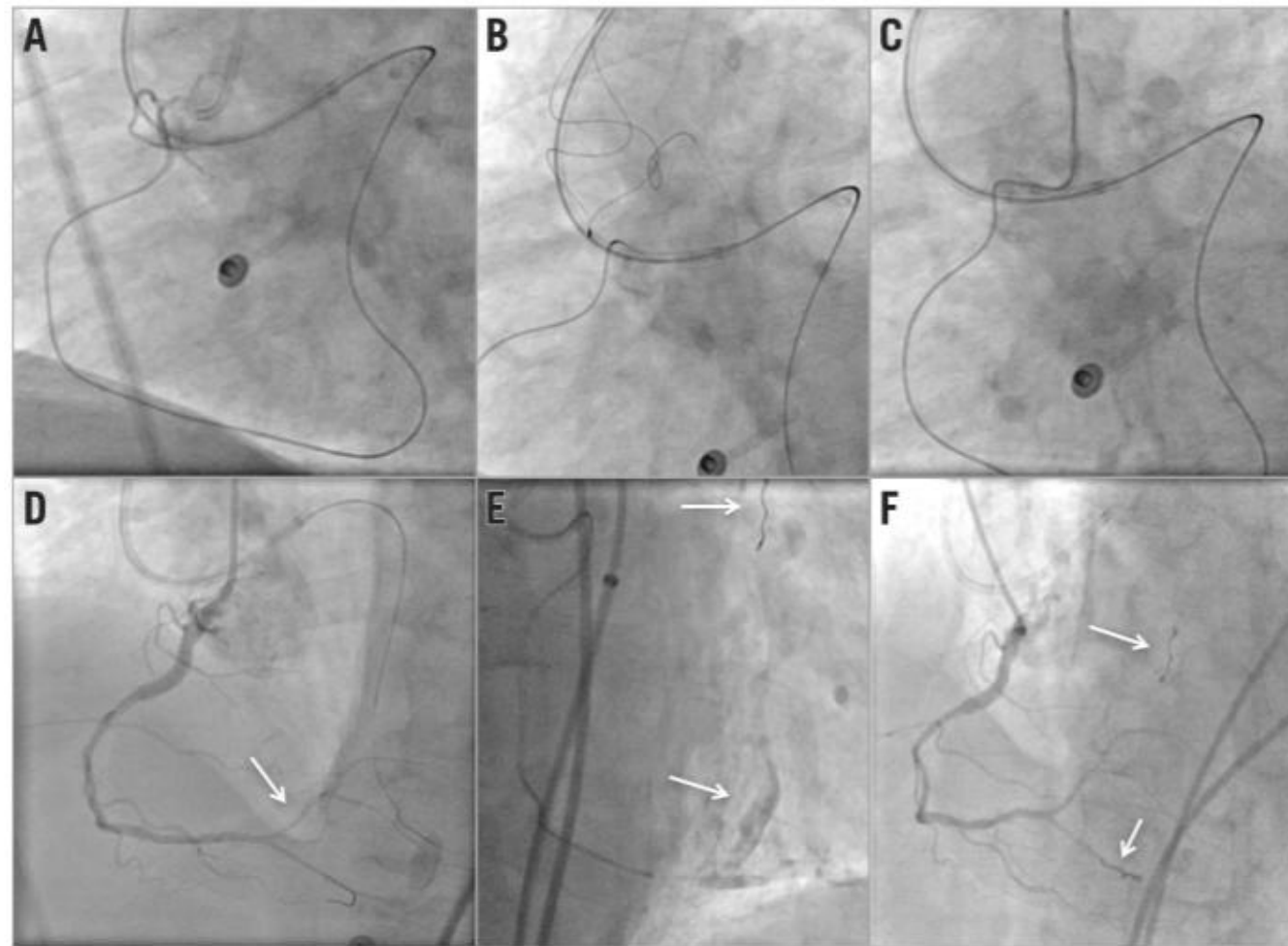


Figure 1. **Figure 6.** Snaring the CTO wire in an aorto-ostial CTO lesion. Angiography visualisation of a massively calcified aorto-ostial CTO of the RCA (A). The retrograde RCA by super-selective contrast injection over the retrograde Corsair MC (A). After retrograde penetration of the CTO with a Confianza 12g, snaring with an EXPRO Elite Snare (Vascular Solutions) (size: 35 mm) is performed within the aortic root (B). The snared retrograde Confianza 12g guidewire had to be pulled back into the antegrade aortic guiding catheter by increasing tractive effort endangering haemodynamics by possibly strangulating the heart (C). After wire externalisation, the ostium of the RCA is treated by PCI/DES implantation. Then, the retrograde Corsair MC protecting contralateral CCs was carefully removed. However, final angiography revealed a huge perforation of intraseptal CCs (white arrow) at the insertion point of the RCA (D). Panels E and F illustrate the implantation of intracoronary coils into a septal CC of the LAD and into the distal branch of the PDA (white arrows).

RCA (A).
r (white
te within the

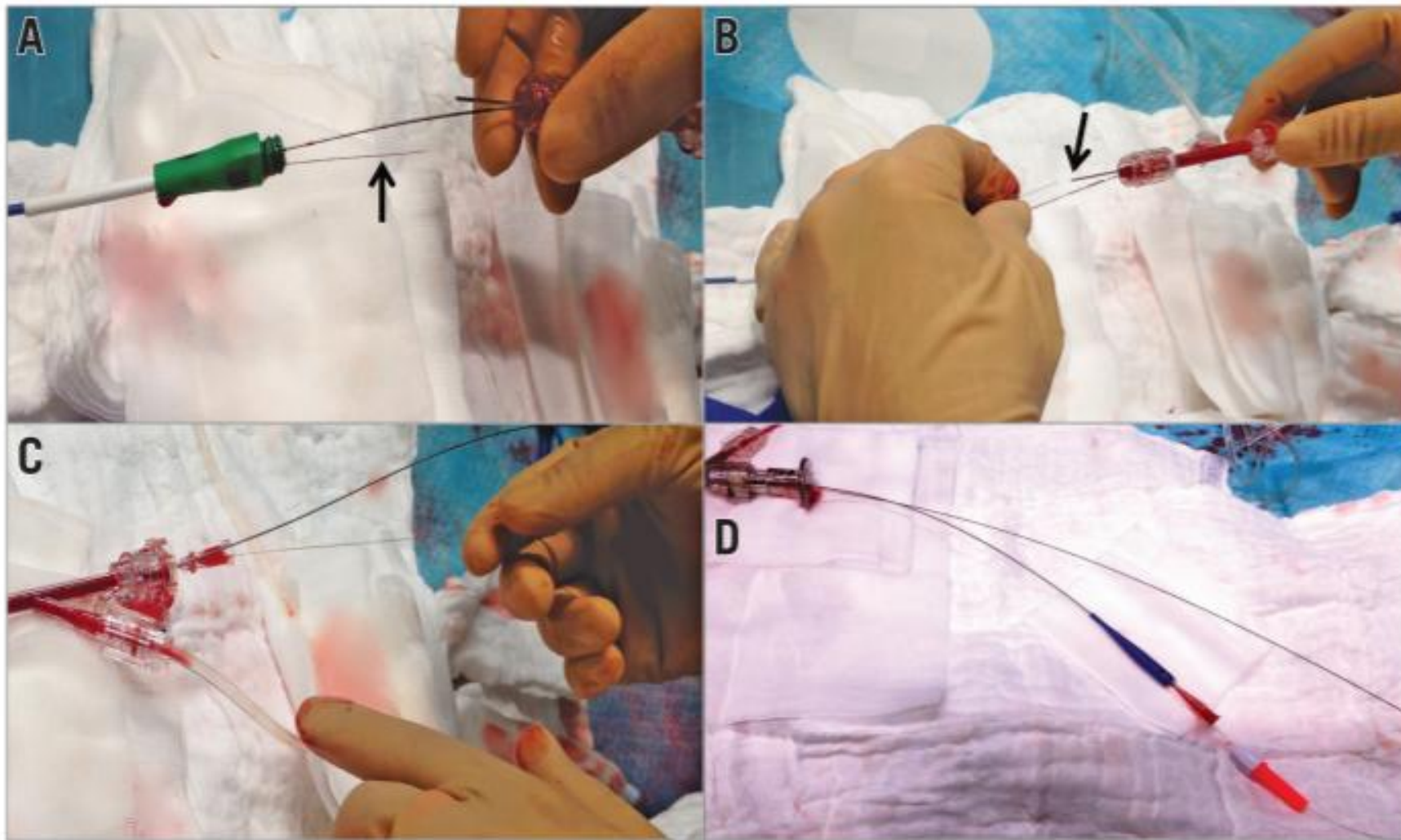


Figure 5. *Illustration of the wire externalisation process outside of the body. The RG3 externalisation wire is externalised through the antegrade guiding catheter (black arrow) (6 Fr) (A). The externalisation wire is engaged to the distal site of the introducer needle (black arrow) placed within the antegrade Y-connector (B). After adjustment of the Y-connector to the guidewire, externalisation can be performed safely (C). In order not to lose the retrograde ending of the externalisation wire, it should be fixed by the torquer in front of the retrograde Corsair MC (D).*

Tool Box

- Cateter extra suporte
- Cateter de extensão
- Guias dedicados para CTO/ Guias de troca/ Guias de externalização/ Guia de CC
- Balão baixo perfil/ balão OTW
- Stent Farmacológico
- Stent recoberto
- Coils/ Microesferas
- Snare
- Microcateteres
- Stingray/ CrossBoss
- IVUS/OCT*
- Rotablator*

Complicações – Ruptura CC

- Epicárdica: hematoma focal ou tamponamento
- Sulco AV: obstrução via entrada ou saída VE, tamponamento
- Septal: Tamponamento seco/ obstrução via saída VE ou VD

Operador deve estar preparado para evitar e manejar as complicações

Perforation management

1. Inflate balloon to occlude vessel
2. Intravenous fluids / pressors
3. Pericardiocentesis if hypotension
– ? autotransfusion
4. Notify surgeons

**“Universal” Algorithm for
Coronary Perforations**

Persistent extravasation?

no

Monitor pt

yes

Treat the cause

Large vessel perforation

1. Covered stent
2. Prolonged balloon inflations

Distal vessel perforation

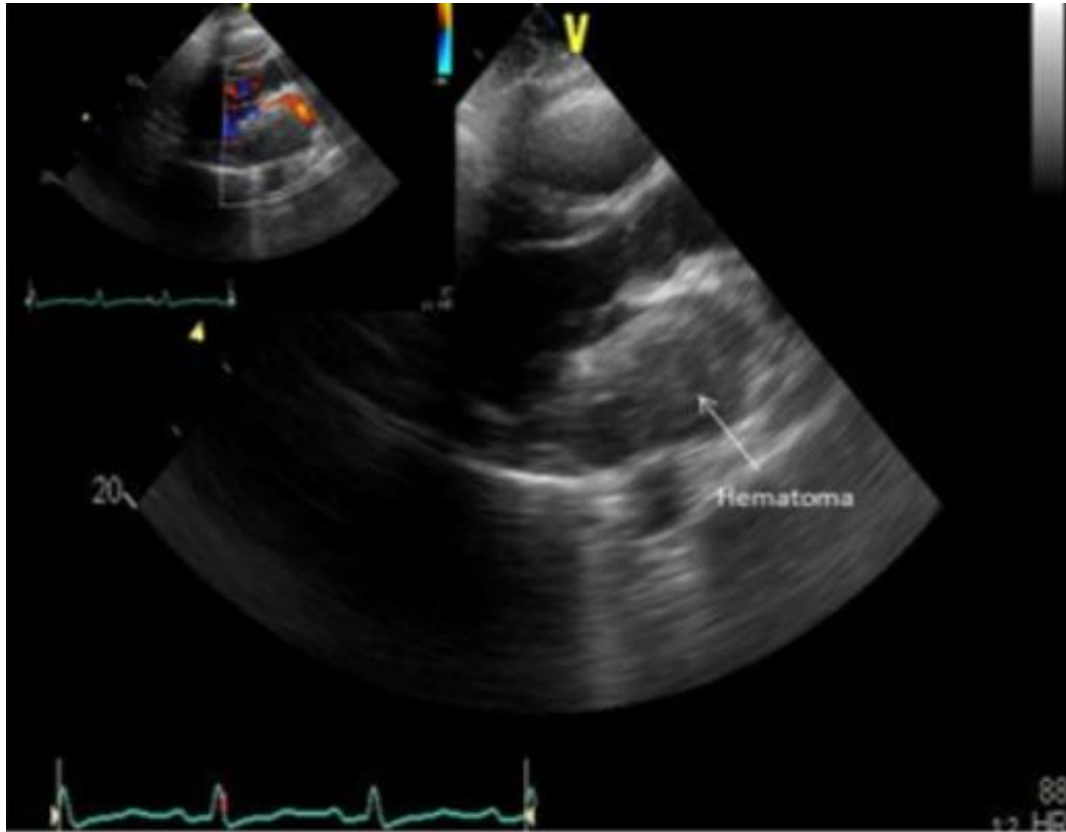
1. embolization (fat, coil, thrombin, etc)
2. Covered stent over perforated branch origin

**Type-specific
Treatment**

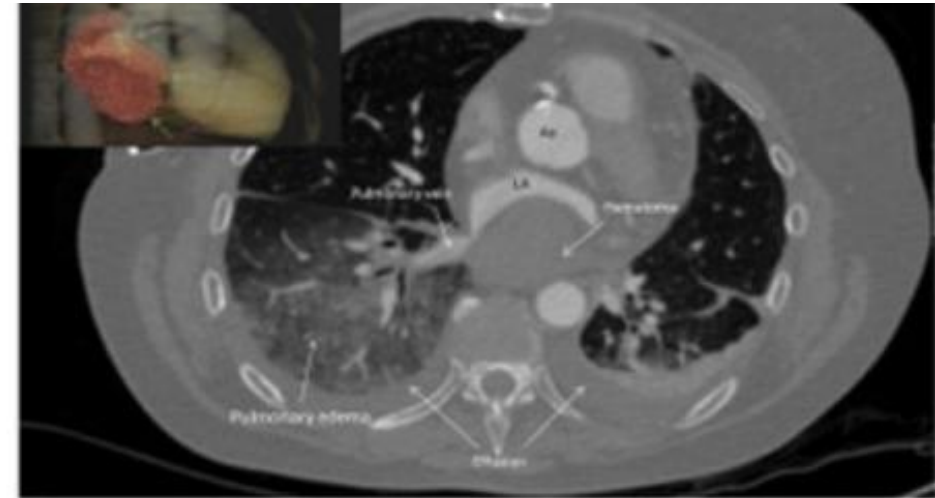
continued extravasation?

Reverse anticoagulation

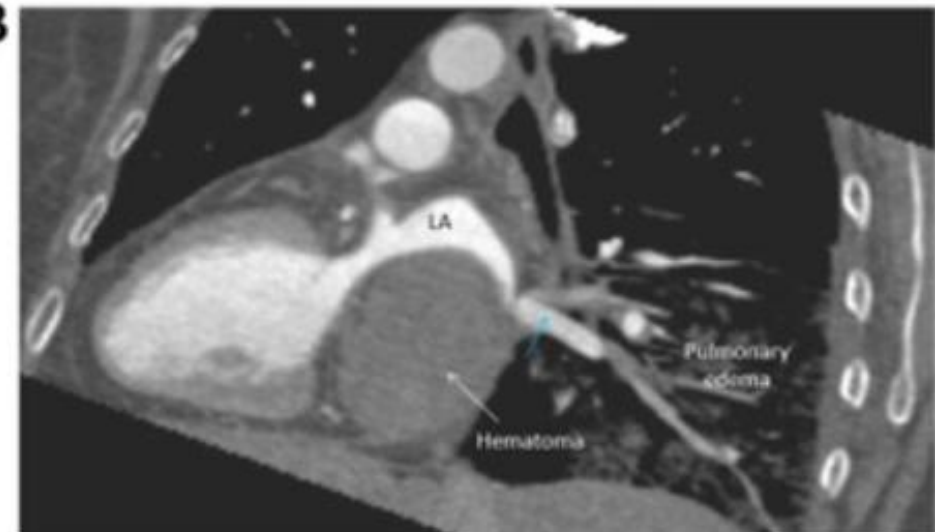
Hematoma AE



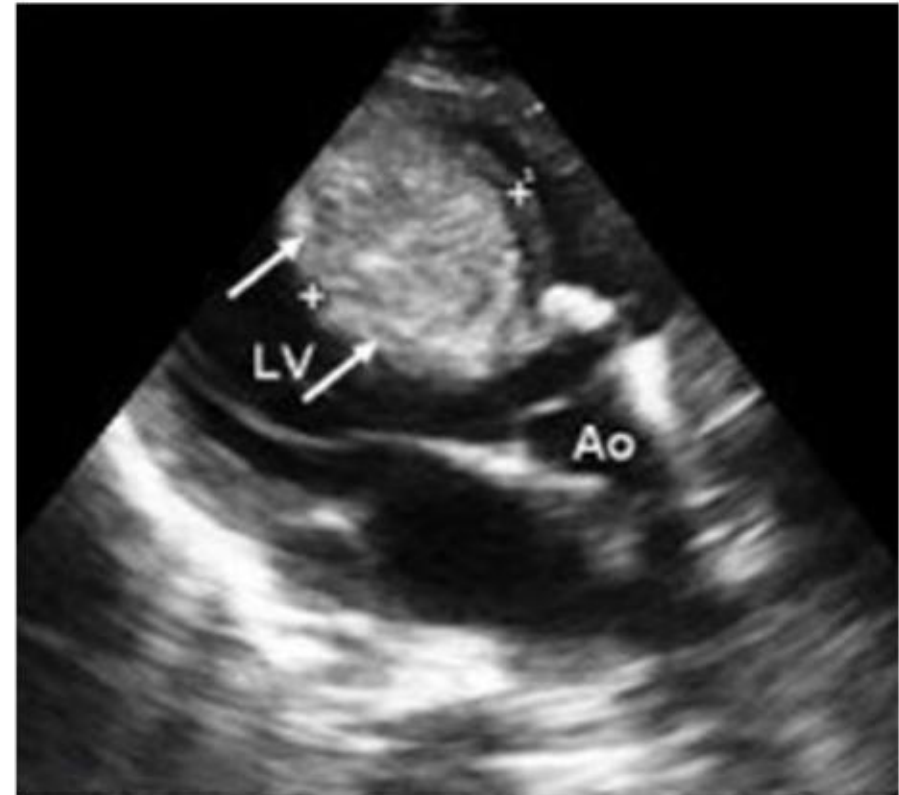
LA inflow/outflow obstruction or annulus deformity causing MR



B

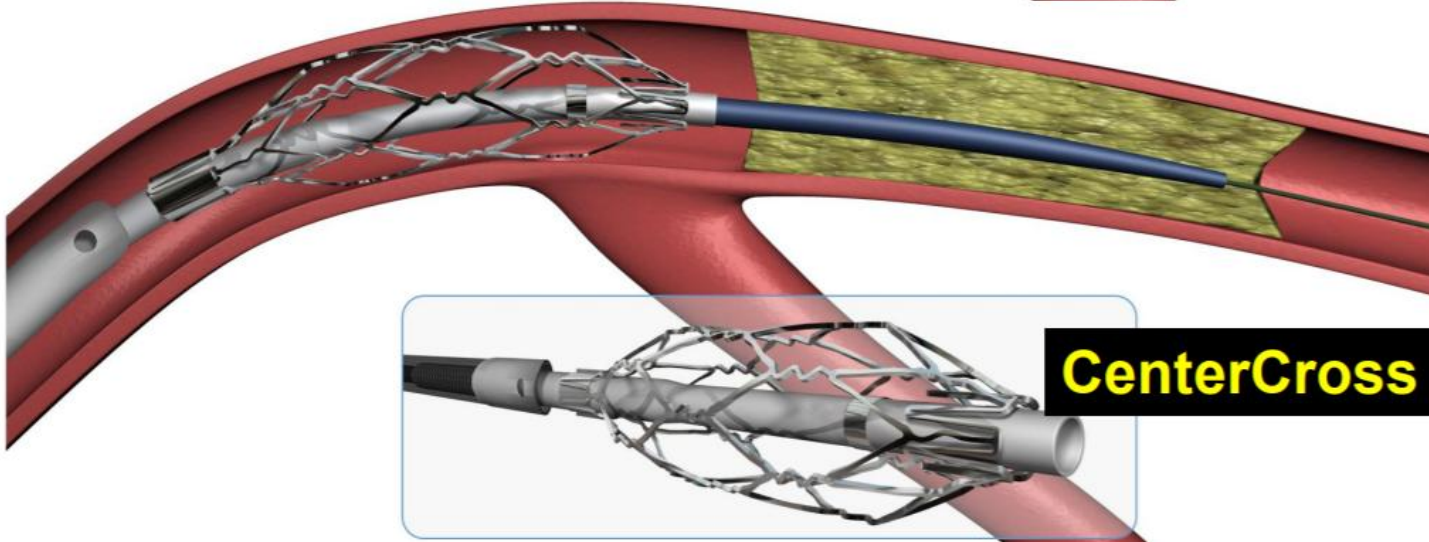
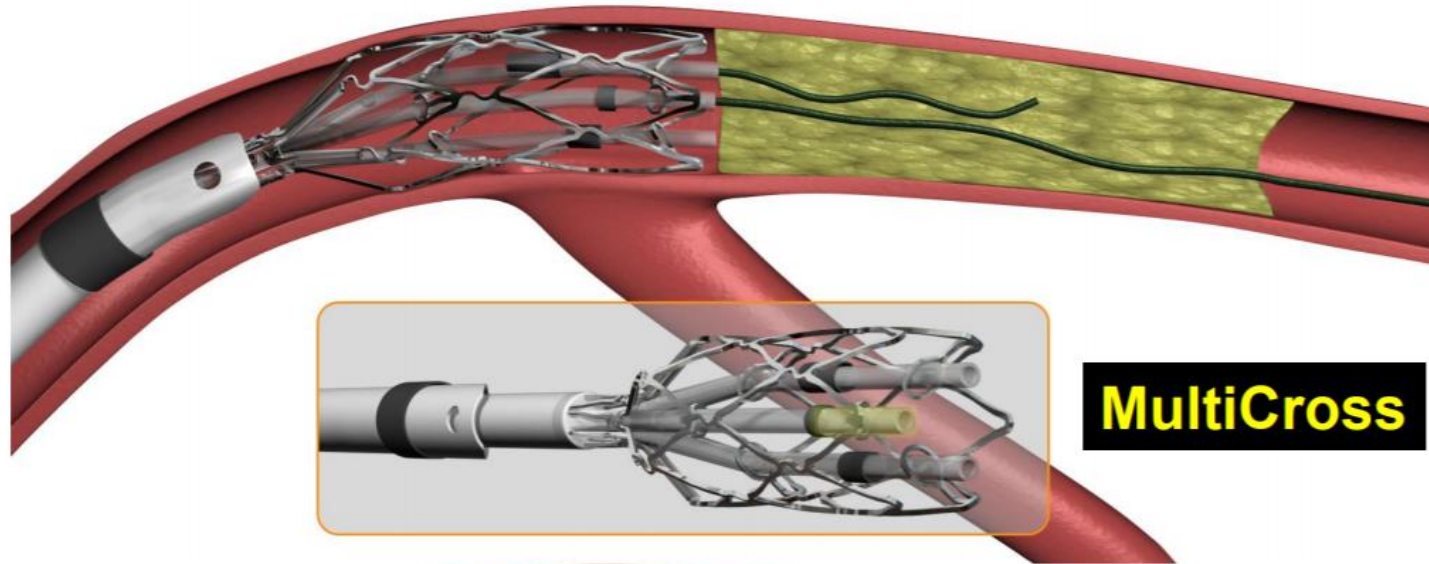


Hematoma Septal



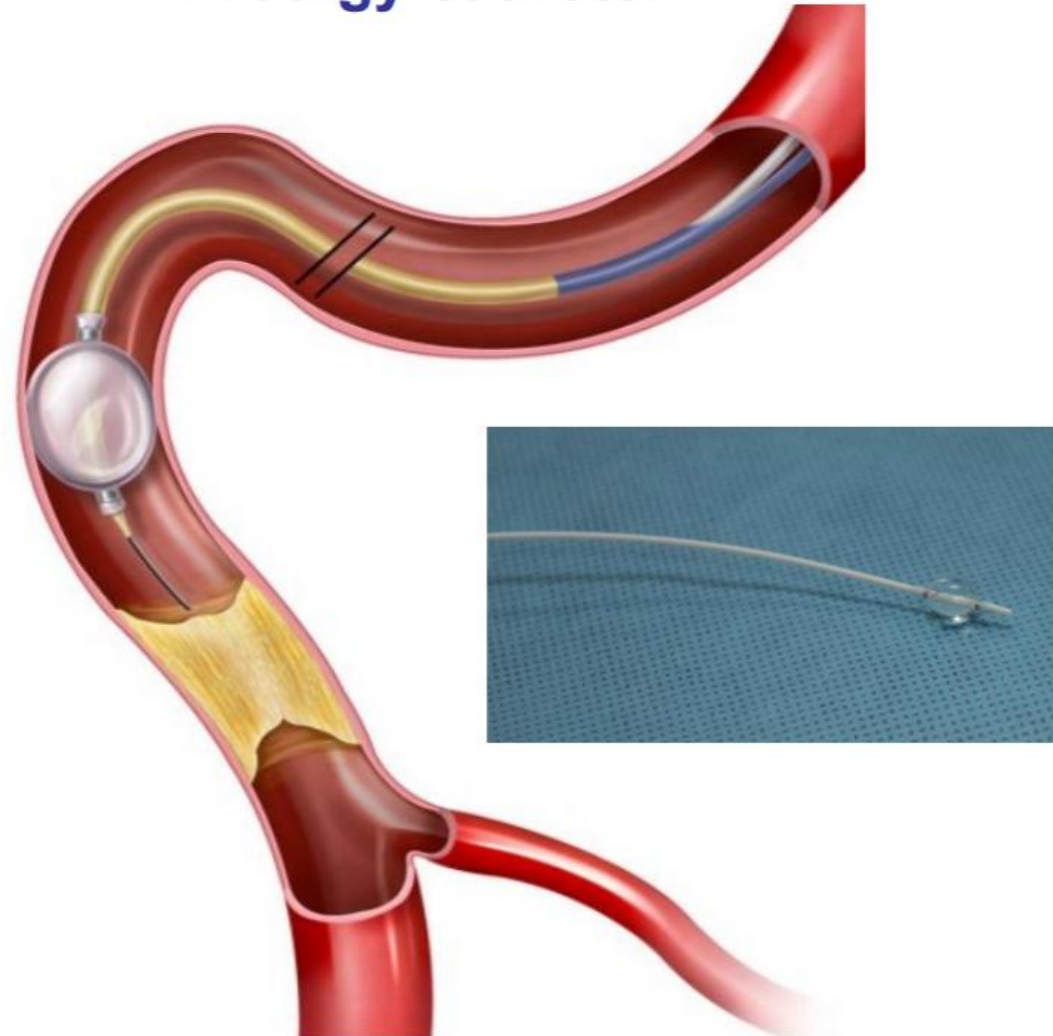
Dry tamponade and/or
LVOT/RVOT obstruction

Novos Dispositivos



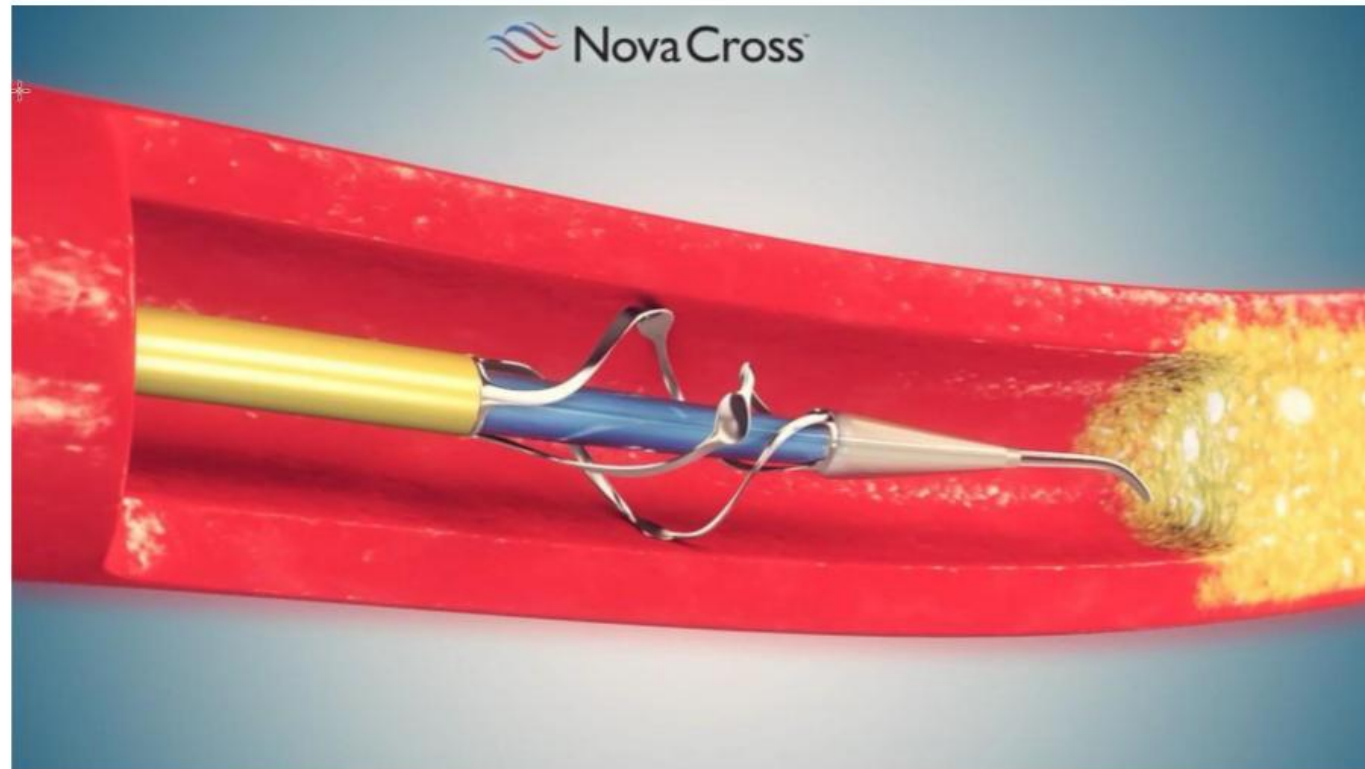
Novos Dispositivos

Prodigy catheter



Novos Dispositivos

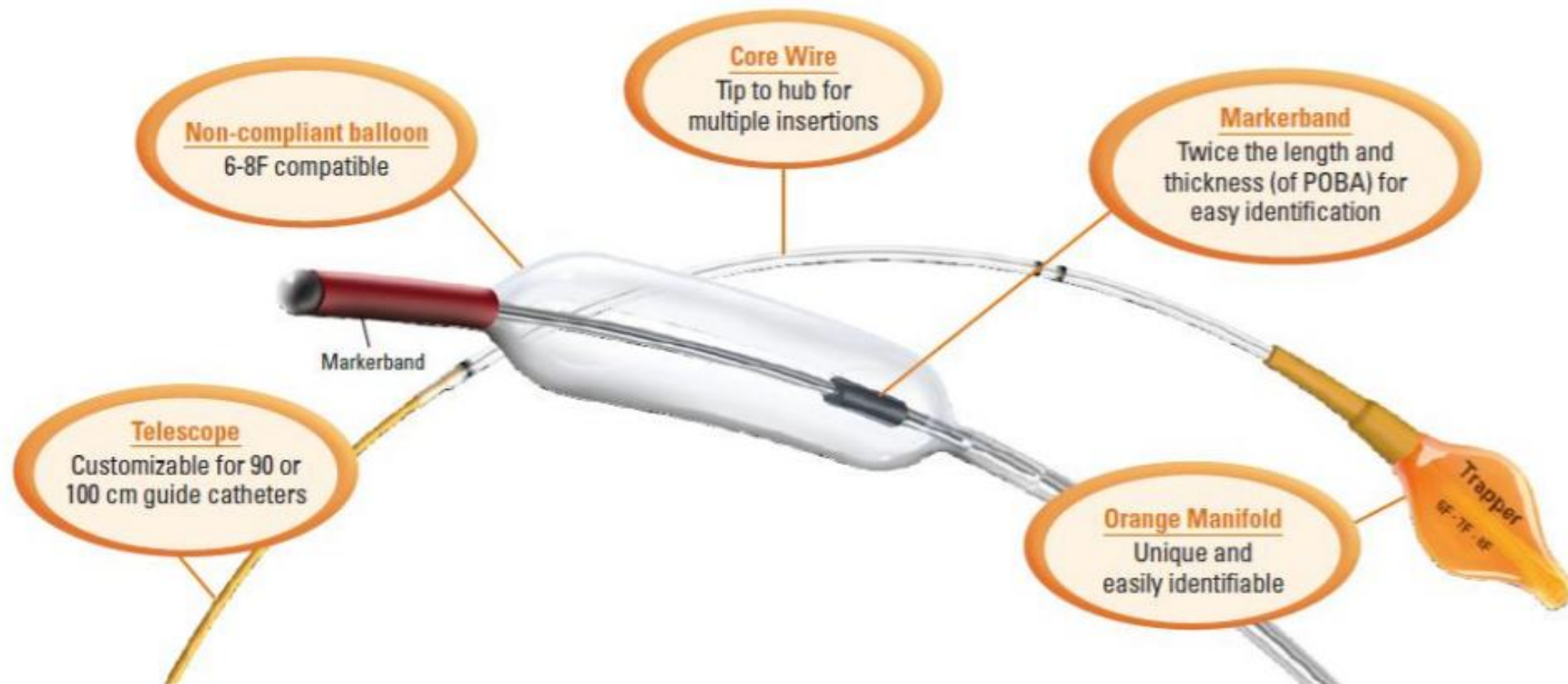
NovaCross



**Outward curving of helical scaffold at distal end
Extends distally up to 5cm**

Novos Dispositivos

Trapper balloon

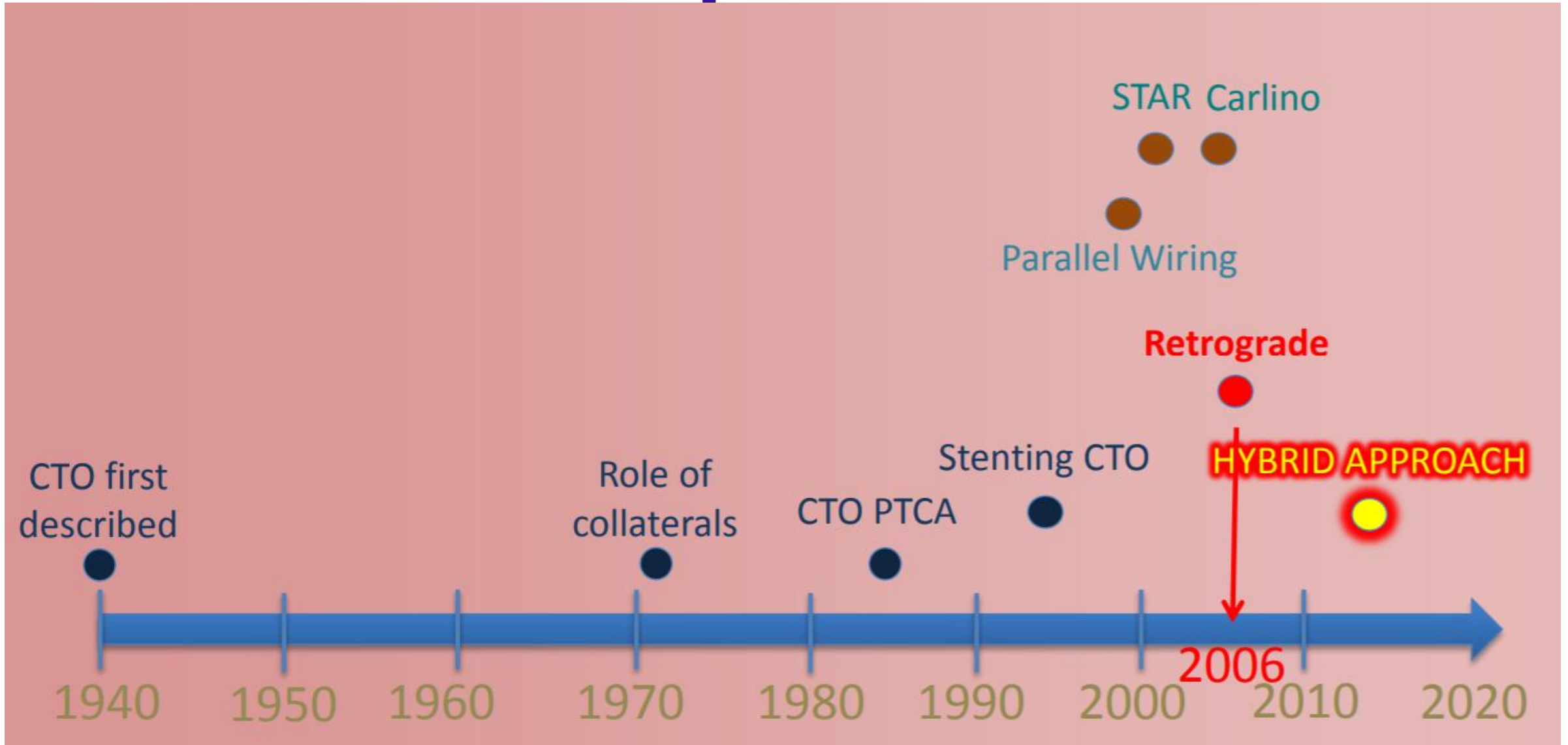


Novos Dispositivos

ELCA coronary laser atherectomy catheter



Perspectivas



Take-Home Messages

- **Master all techniques**
- **Plan A, Plan B, Plan C**
- **Change plans quickly**
- **Keep it as simple as possible**

Considerações Finais

- Os pacientes de CTO são subtratados
- ICP CTO contemporânea pode alcançar alta taxa de sucesso com taxa de complicação aceitável
- Implementar treinamento mais difundido para crescer números de operadores especializados e expandir alcance geográfico, continuando a melhorar os dispositivos e técnicas de ICP para aumentar as taxas de sucesso (e simplicidade) para operadores não especializados e especializados.
- Rever vias de reembolso, de modo que não seja mais um impedimento para todos os pacientes com CTOs receberem intervenção adequada.
- Temos uma longa jornada pela frente antes que a fronteira final de ICP em CTO seja conquistada, embora, finalmente, este horizonte esteja à vista.

OS PRIMEIROS ENTUSIASTAS DO HCI!!
OBRIGADO!!

