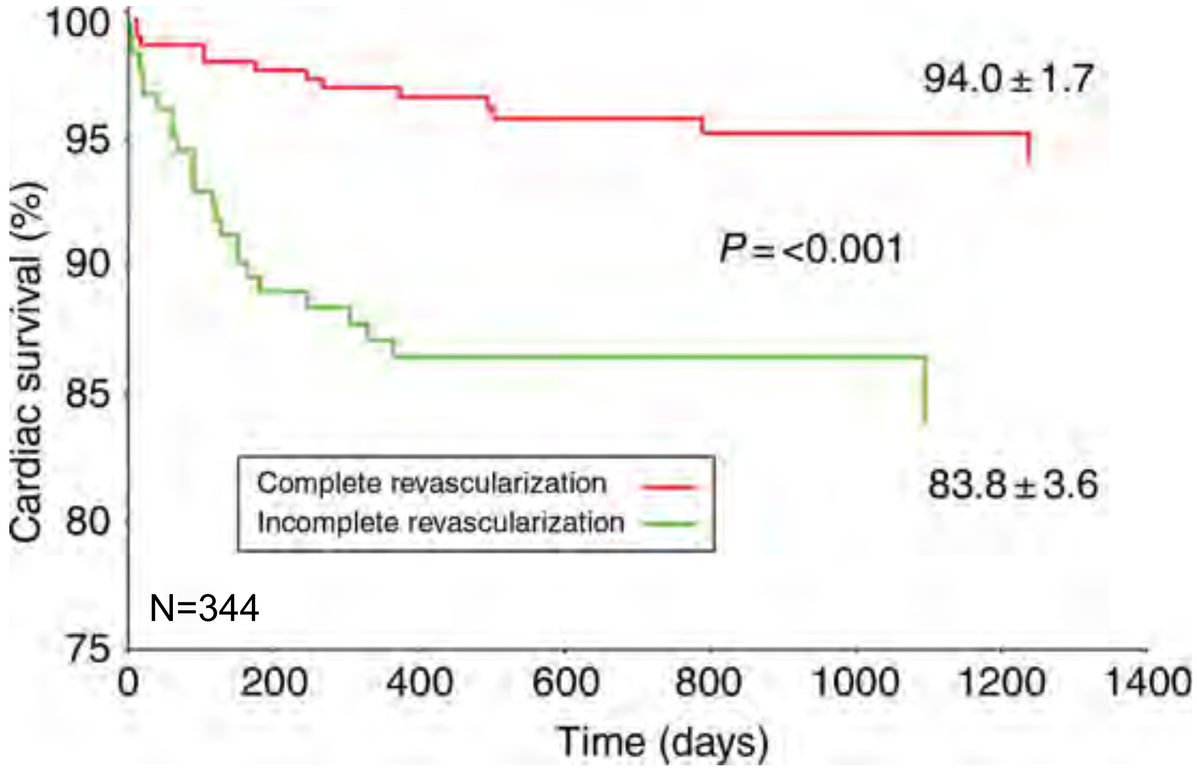
Chronisch verschlossene Herzkranzgefässe

Gregor Leibundgut

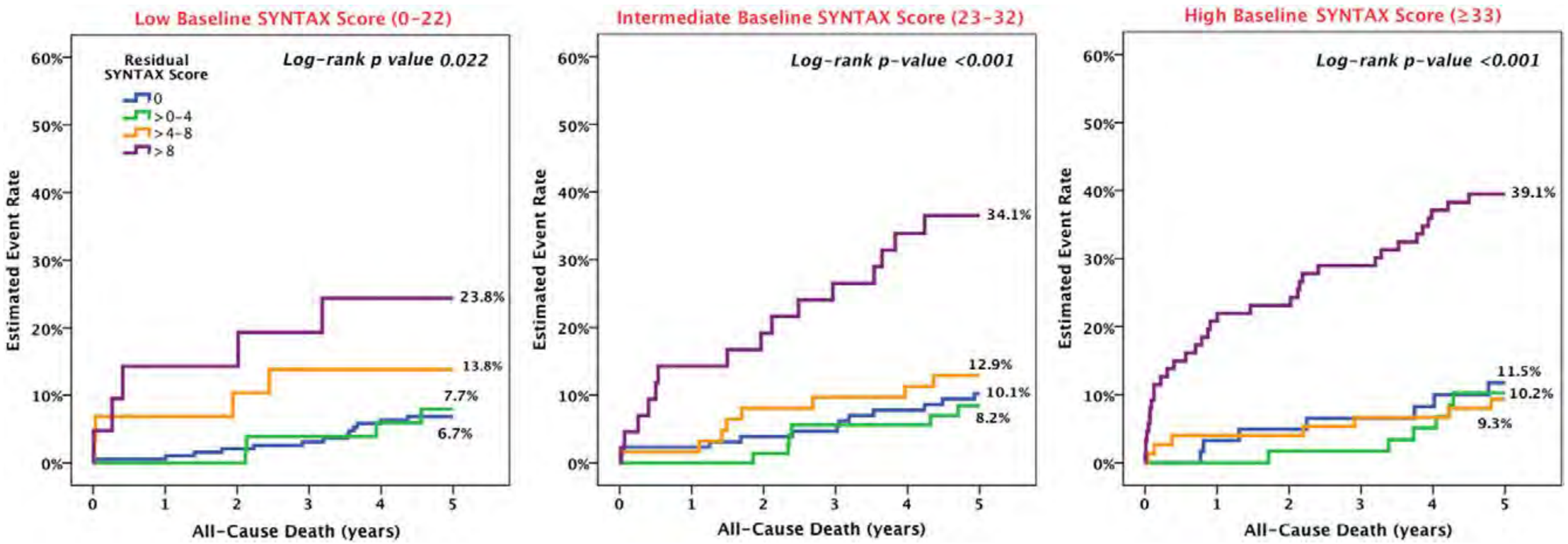
Komplettheit der Revaskularisation

Patienten mit mind. einer CTO



Residueller SYNTAX Score

Mortalität



Farooq V et al. Circulation 2013;128:141

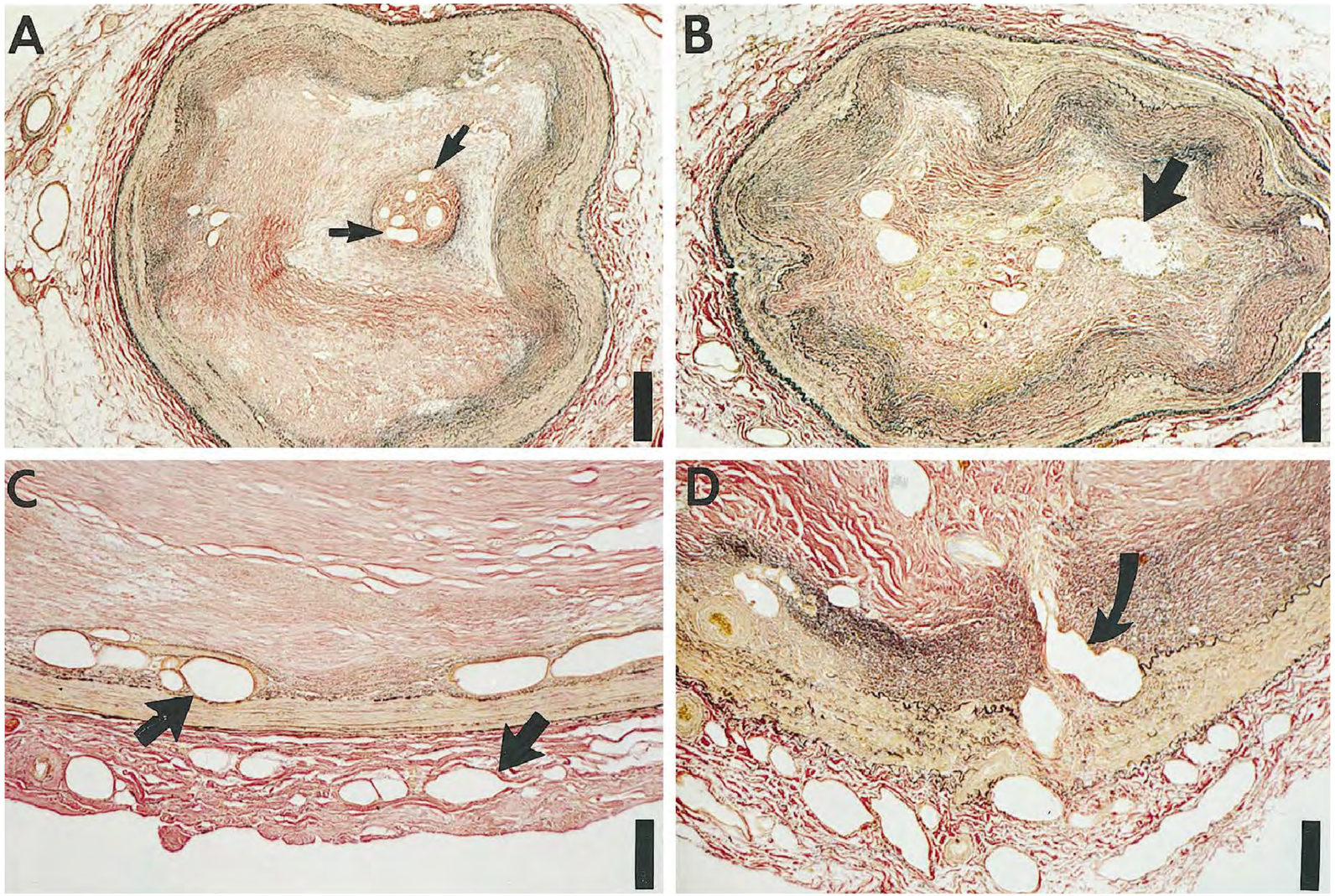
CTO - Chronic Total Occlusion

- Kompletter Koronarverschluss
  - TIMI 0 grade Blutfluss
  - antegrade und/oder retrograde Kollateralen
- Verschlussdauer > 3 Monate
  - angiographisch
  - klinisch
- Viabilität ?

- 15-30% aller Koronarangiographien !

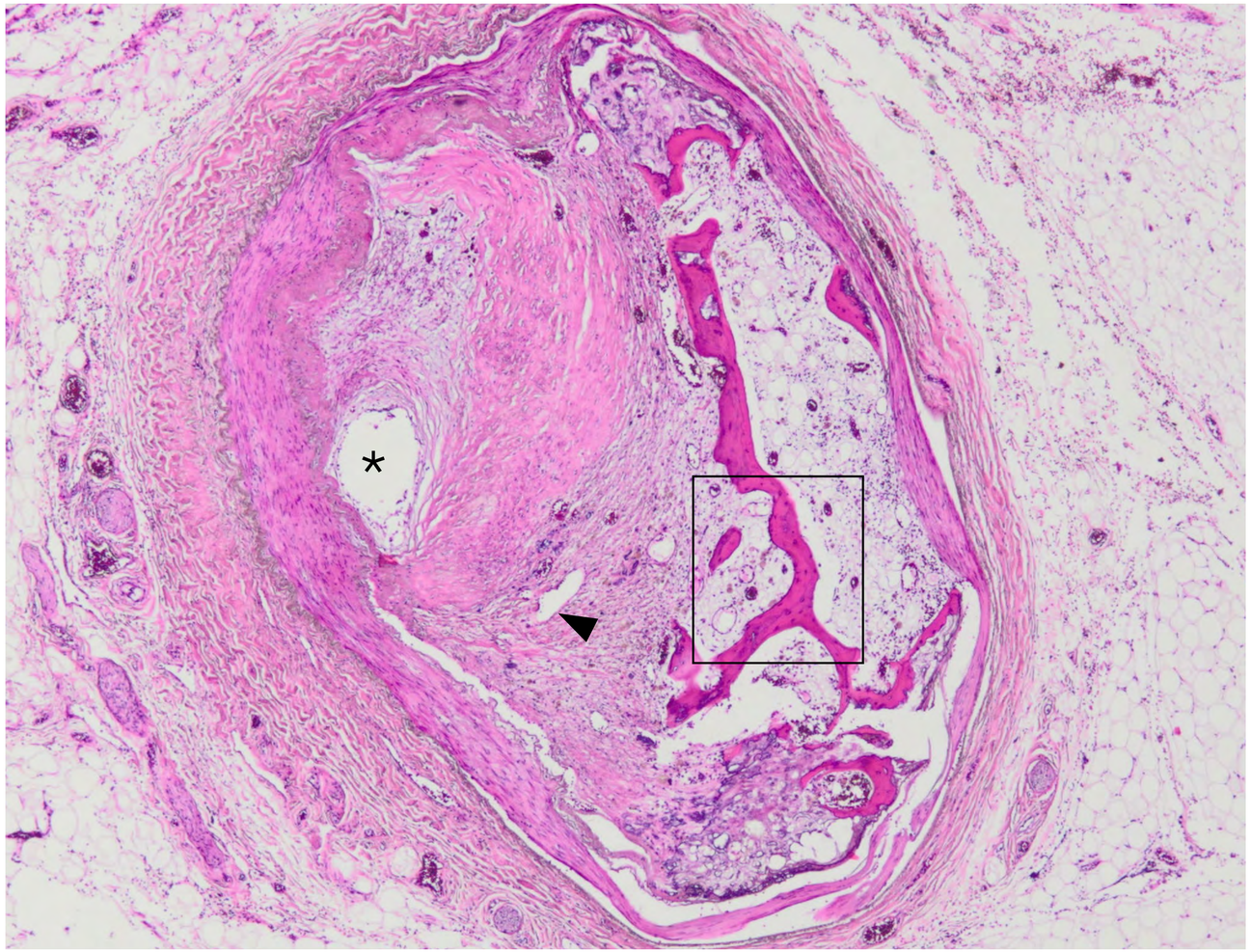
- Gefässbeteiligung
  - ACD 60%
  - RIA 22%
  - RCX 18%
  - multiple locations 17%
  - proximal segment 68%

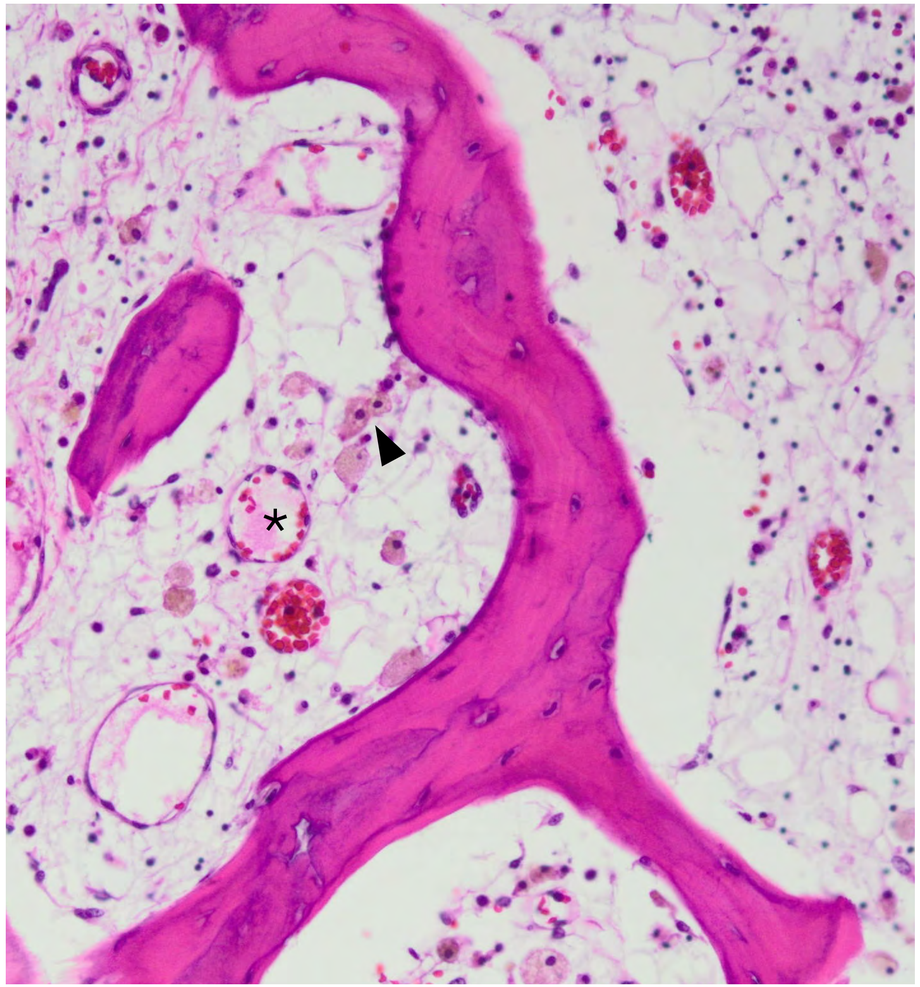
Histologie



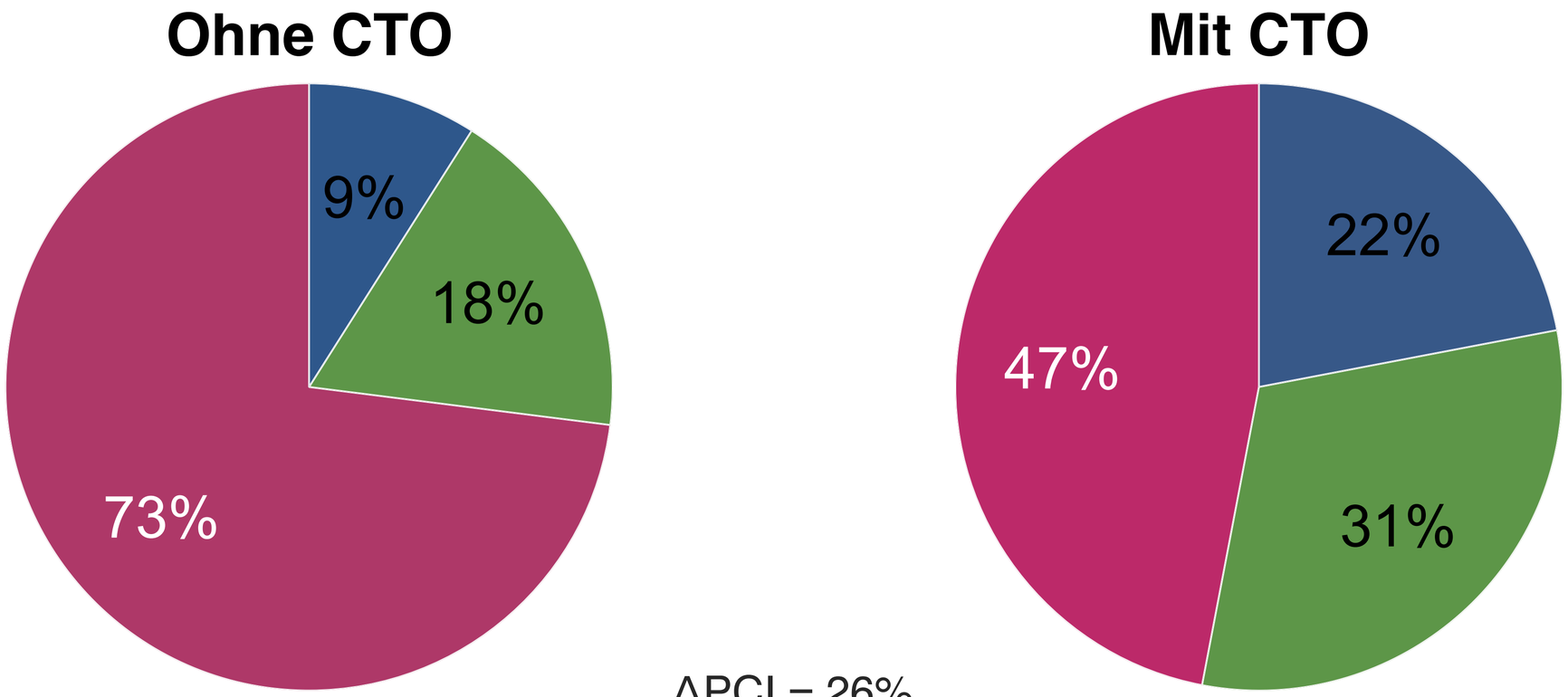
Srivatsa et al. JACC 1997;29:955-63

Koronarknochen



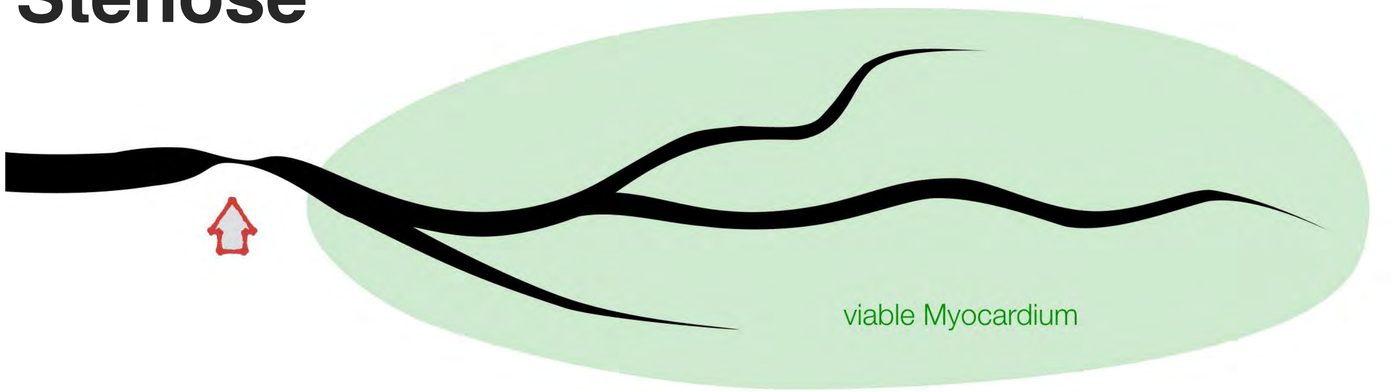


Therapieoptionen



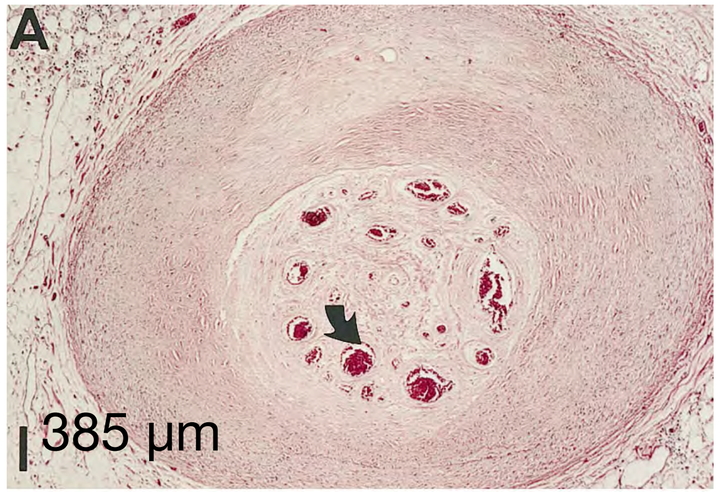
Wo liegt der Unterschied?

Stenose



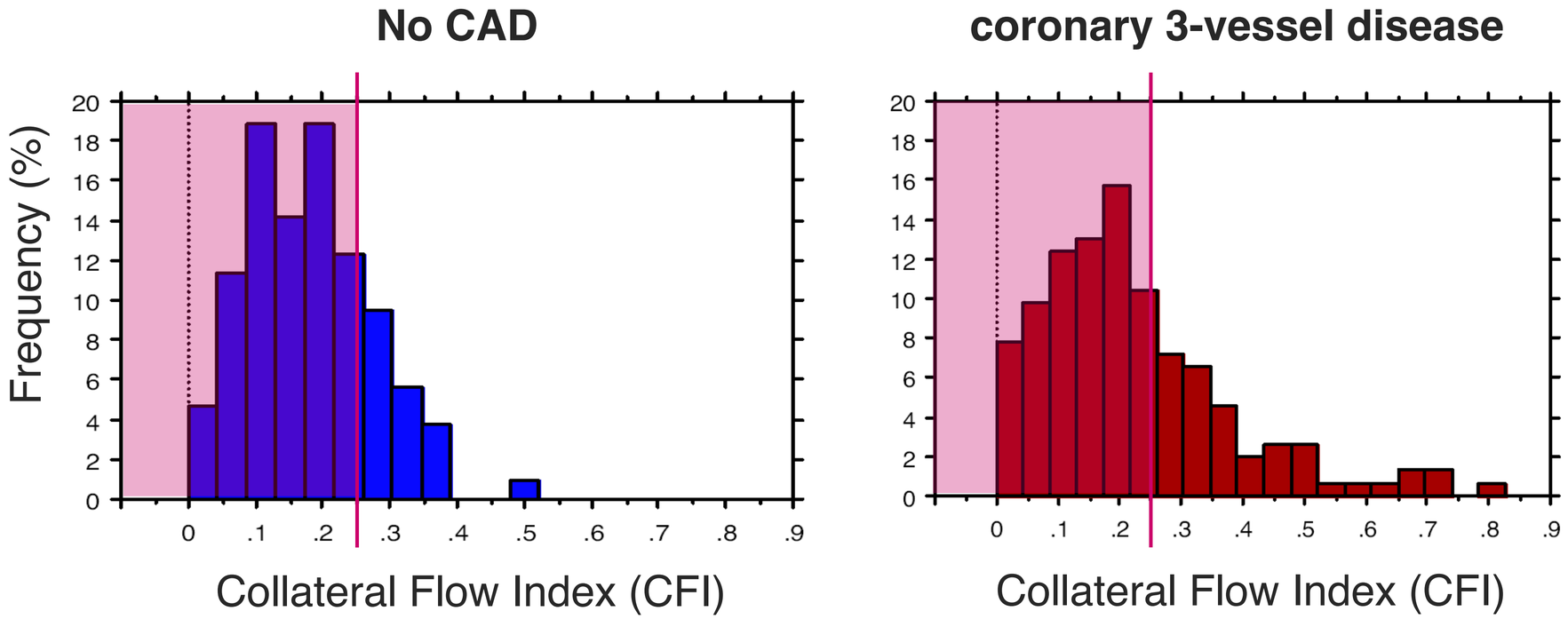
CTO

It’s all about Collaterals!



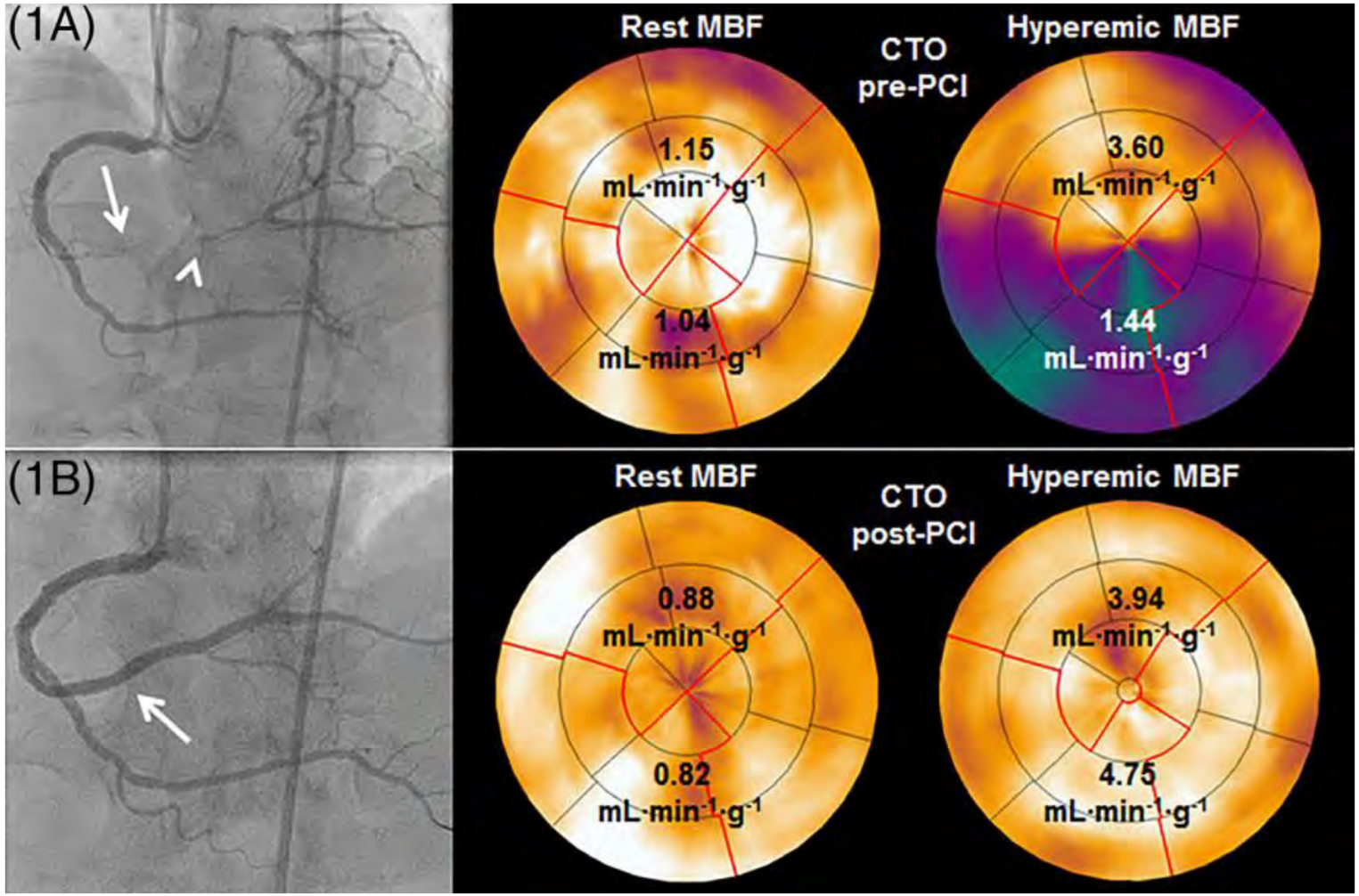
Ausreichende Kollateralisation?

In nur 20% nach akutem Koronarverschluss (CFI >0.25)

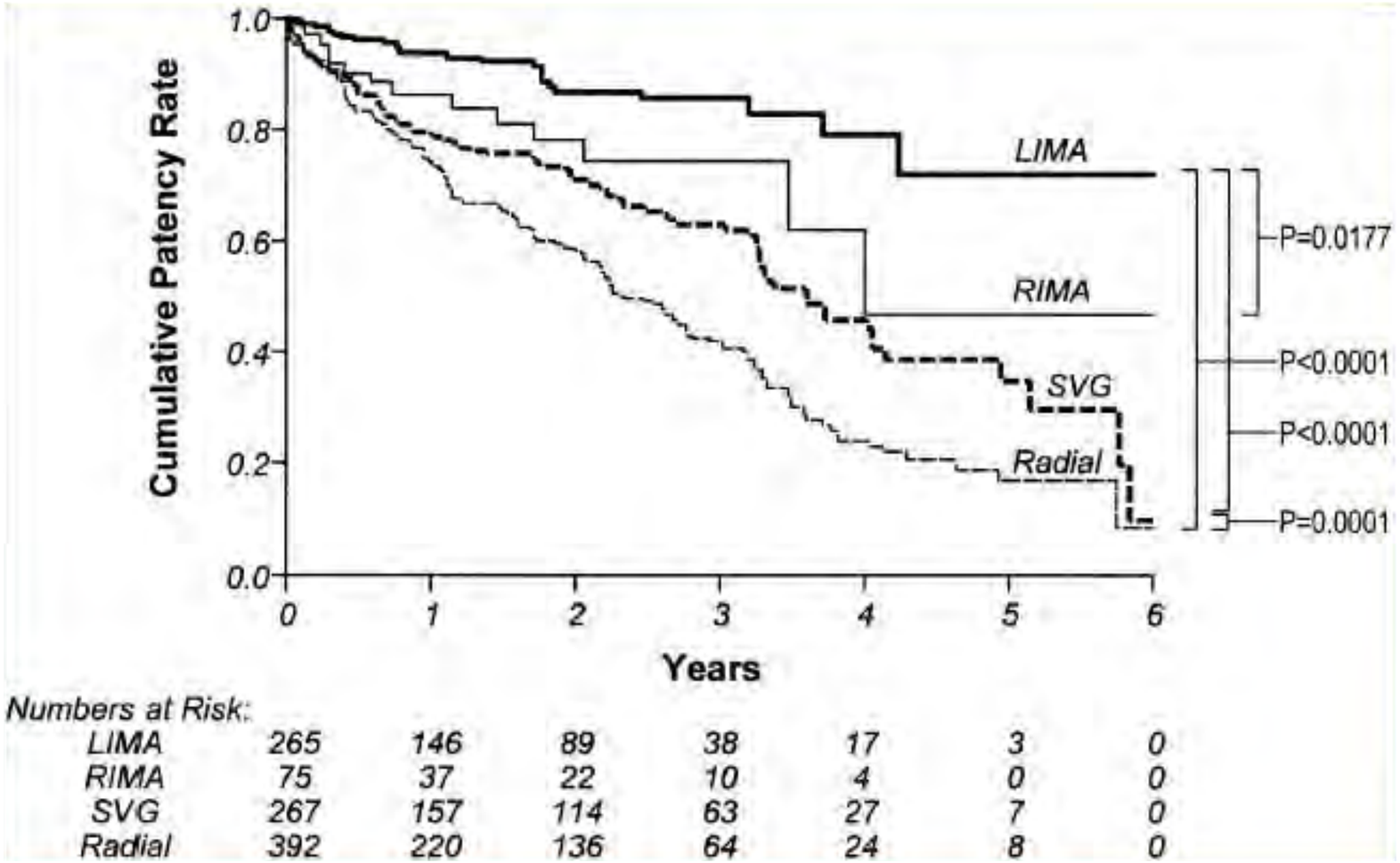


$$CFI = \frac{p_{occl} - CVP}{p_{aorta} - CVP}$$

PET Perfusion nach CTO-PCI



Lebensdauer der Bypässe



Numbers at Risk:

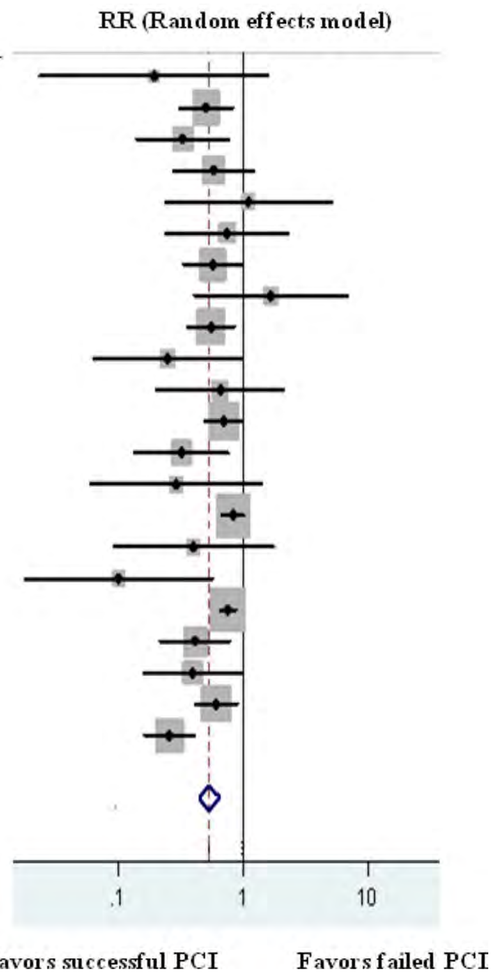
LIMA	265	146	89	38	17	3	0
RIMA	75	37	22	10	4	0	0
SVG	267	157	114	63	27	7	0
Radial	392	220	136	64	24	8	0

Khot UN et al. Circulation 2004;109:2086

Meta-Analyse nach CTO-PCI

23 Observational Studies, 12,970 patients, mean f/u 3.7±2.1 yrs

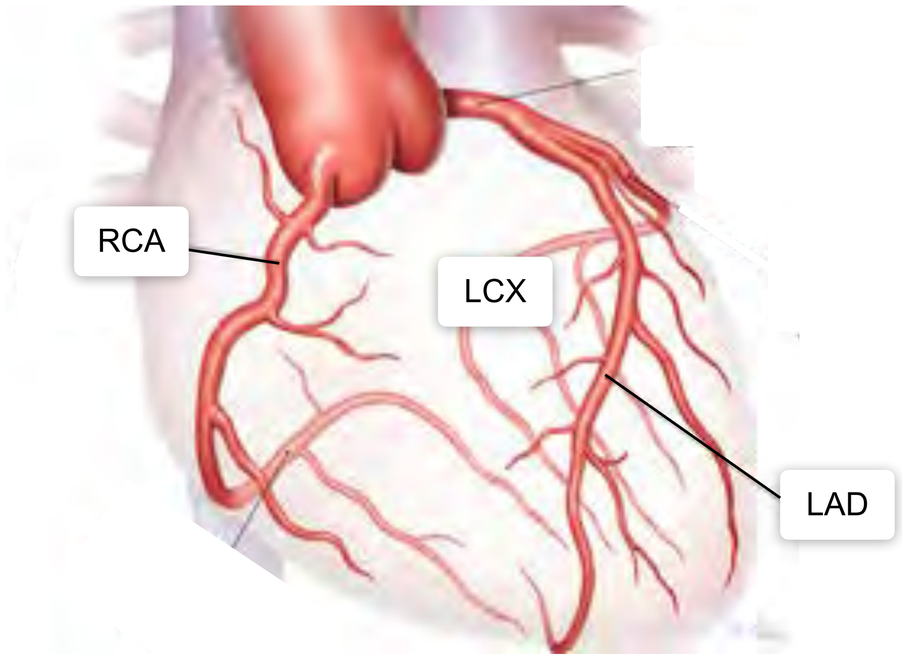
Study	PCI success n/N	PCI failure n/N	RR(95%CI)	%Weights
Angioi	1/93	6/108	0.19(0.02-1.58)	0.76
Arslan	9/117	37/115	0.50(0.31-0.82)	6.77
Aziz	9/377	12/166	0.33(0.14-0.77)	3.56
Borgia	19/237	9 /65	0.58(0.28-1.22)	4.24
de Labriolle	7/127	2 /40	1.10(0.24-5.01)	1.35
Drozd	7/280	5/149	0.74(0.24-2.31)	2.28
Jolicoeur	22/213	24/133	0.57(0.34-0.98)	6.20
Finci	5/100	3/100	1.67(0.41-6.78)	1.58
Hoye	37/567	36/304	0.55(0.36-0.85)	7.45
Ivanhoe	3/317	6/158	0.25(0.06-0.98)	1.64
Lee	8/251	4 /82	0.65(0.20-2.11)	2.14
Mehran	74/1226	49/565	0.70(0.49-0.98)	8.75
Noguchi	7/134	15/92	0.32(0.14-0.76)	3.49
Olivarl	3/286	3 /83	0.29(0.06-1.41)	1.28
Prasad	220/914	101/348	0.83(0.68-1.01)	10.90
Sathe	3/116	4 /62	0.40(0.09-1.73)	1.46
Chen	2/132	3/20	0.10(0.02-0.57)	1.09
Suero	395/1491	179/514	0.76(0.66-0.88)	11.58
Valenti	17/344	17/142	0.41(0.22-0.78)	5.08
Yang	7/87	10/49	0.39(0.16-0.97)	3.25
YiX	135/1202	24/130	0.61(0.41-0.90)	8.05
Jones	26/582	44/254	0.26(0.16-0.41)	7.12
Warren	0/26	0/18	(Excluded)	
D+L pooled * RR	1156/9219	593/3697	0.54(0.45-0.65)	100.00

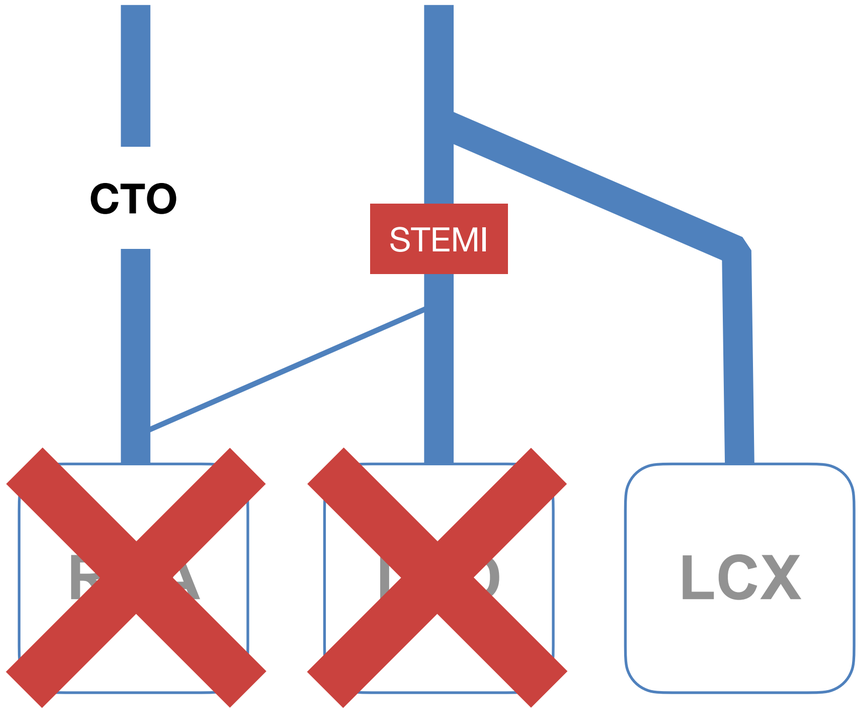


all-cause mortality

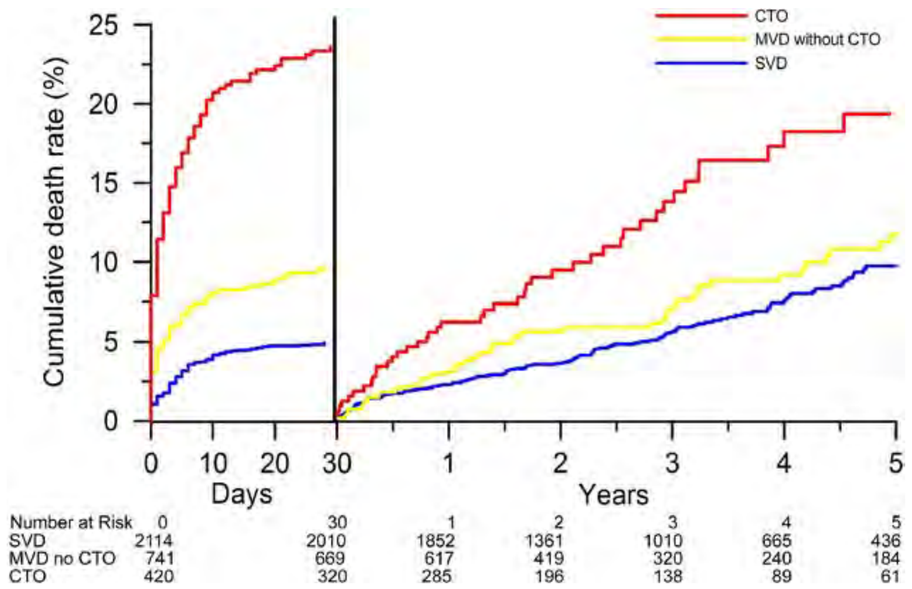
RR **0.54** (95%-CI 0.446-0.650) p<0.001

Chronischer und Akuter Koronarverschluss





Einfluss einer CTO auf die Mortalität beim Herzinfarkt

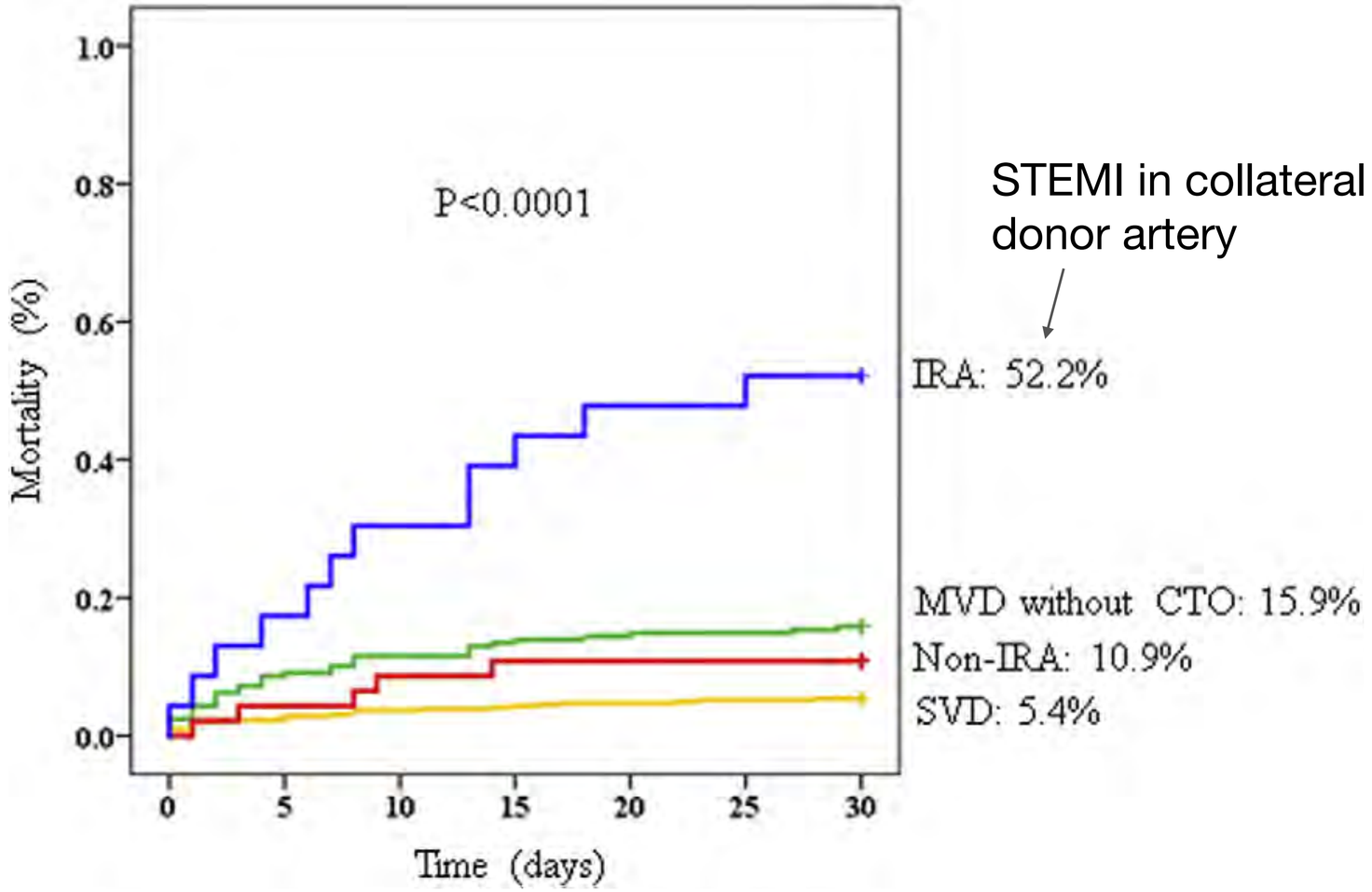


CTO nicht im Infarktgefäss

Table 2. **Independent Predictors for Death During the First 30 Days and During 30 Days to 5 Years After Primary PCI**

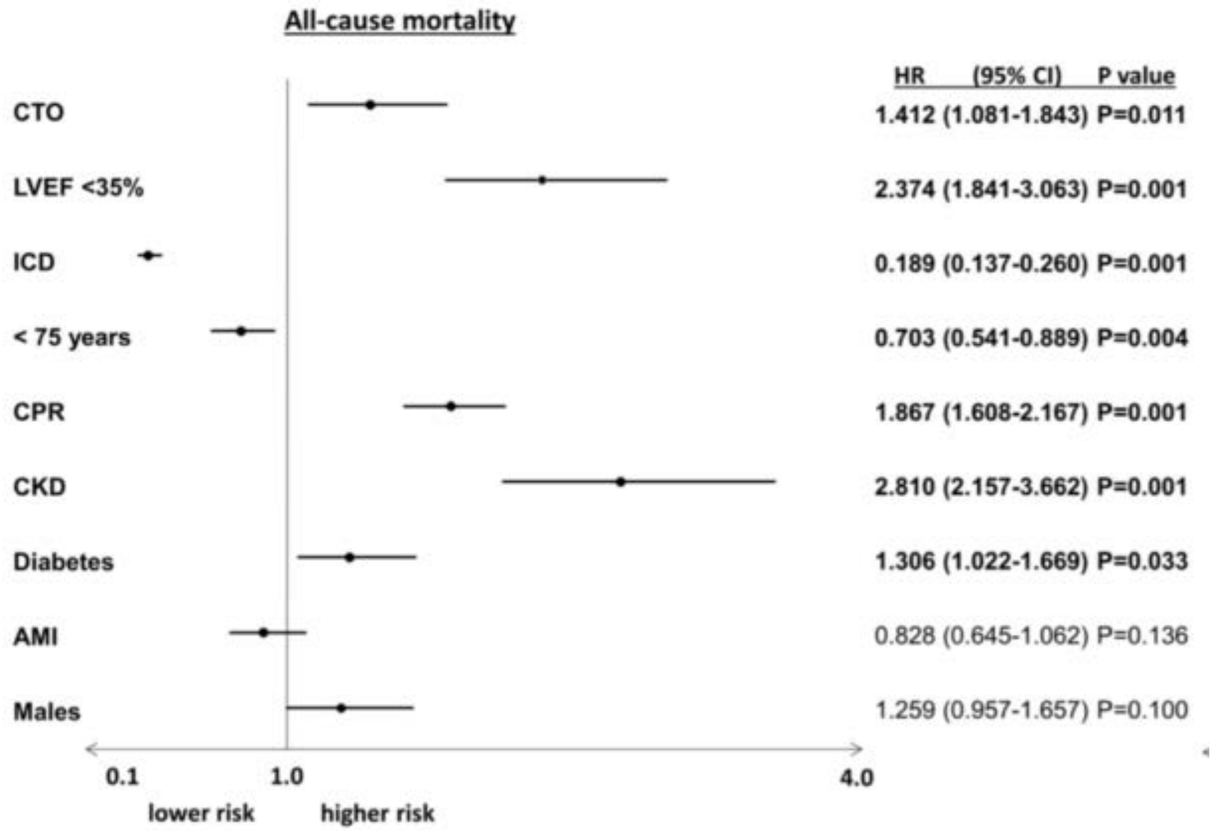
	Predictors for Death During the First 30 Days After Primary PCI			Predictors for Death From 30 Days to 5 Yrs After Primary PCI		
	HR	95% CI	p Value	HR	95% CI	p Value
Shock	7.4	5.8–9.6	<0.01	1.6	1.0–2.4	0.04
CTO	3.6	2.6–4.7	<0.01	1.9	1.4–2.8	<0.01
MVD without CTO	1.6	1.2–2.2	0.01	1.1	0.8–1.6	0.51
LAD-related MI	1.4	1.1–1.7	0.01	1.7	1.3–2.2	<0.01
Hypertension	0.7	0.5–0.9	<0.01	1.1	0.8–1/5	0.52
Hypercholesterolemia	0.6	0.5–0.9	<0.01	0.8	0.6–1.1	0.12
Smoking	0.5	0.4–0.7	<0.01	0.8	0.6–1.0	0.07
Post-PCI TIMI flow grade 3	0.4	0.3–0.5	<0.01	0.6	0.5–0.9	<0.01
Age >60 yrs	1.3	0.9–1.7	0.13	3.3	2.4–4.5	<0.01

STEMI im Kollateralen abgebenden Gefäss

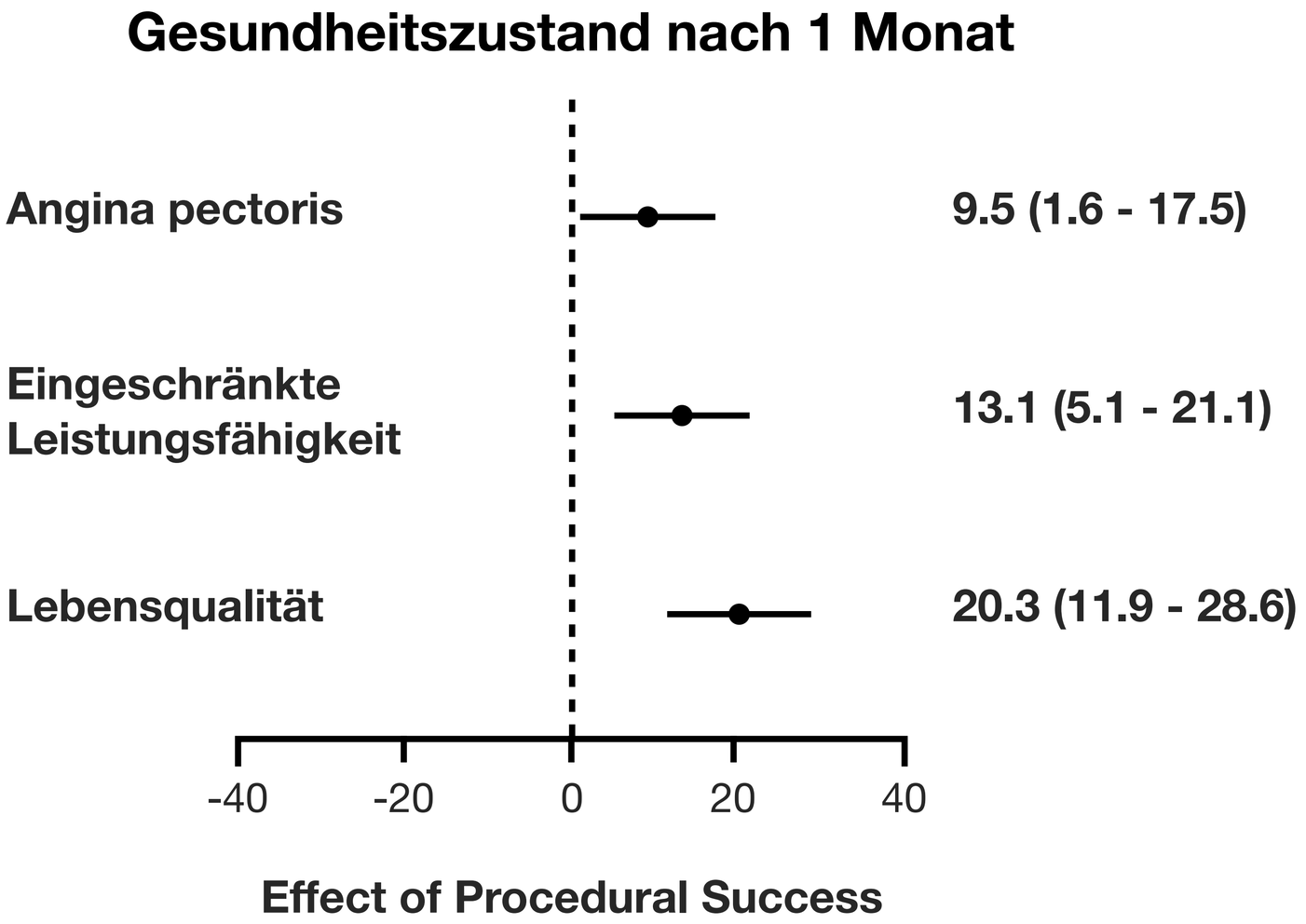


Erhöhte Mortalität bei Kammertachykardien

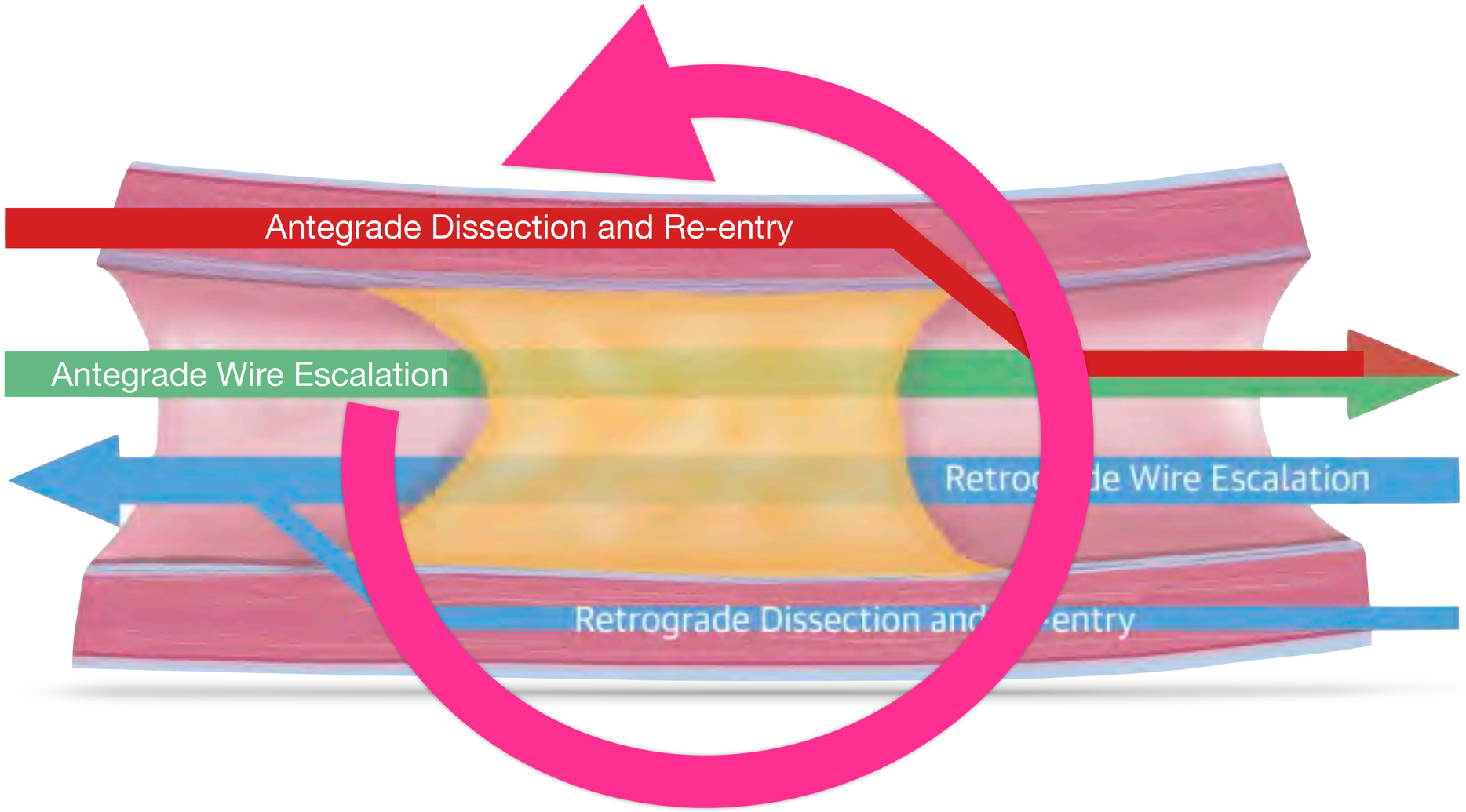
1,461 pts with arrhythmias, 20% had CTO
Mortality (mean 18 months) of 46% with CTO vs. 27% without CTO



Lebensqualität nach erfolgreicher CTO-PCI

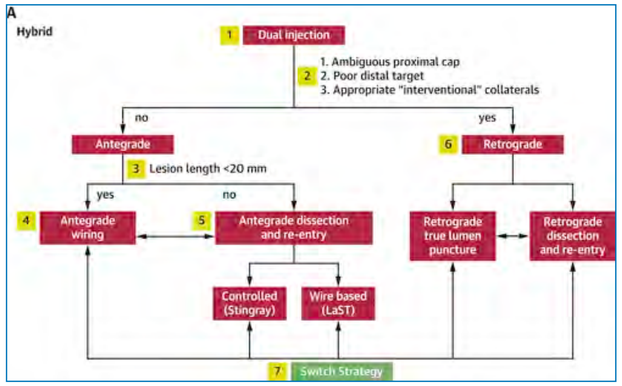


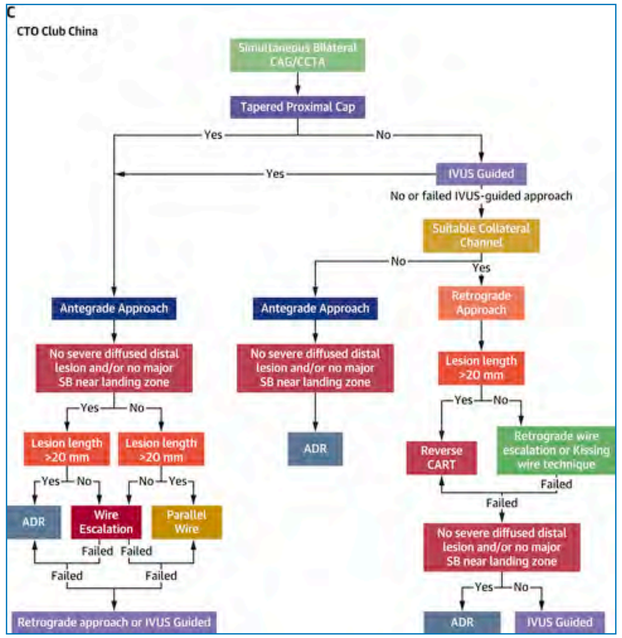
The Hybrid Algorithm

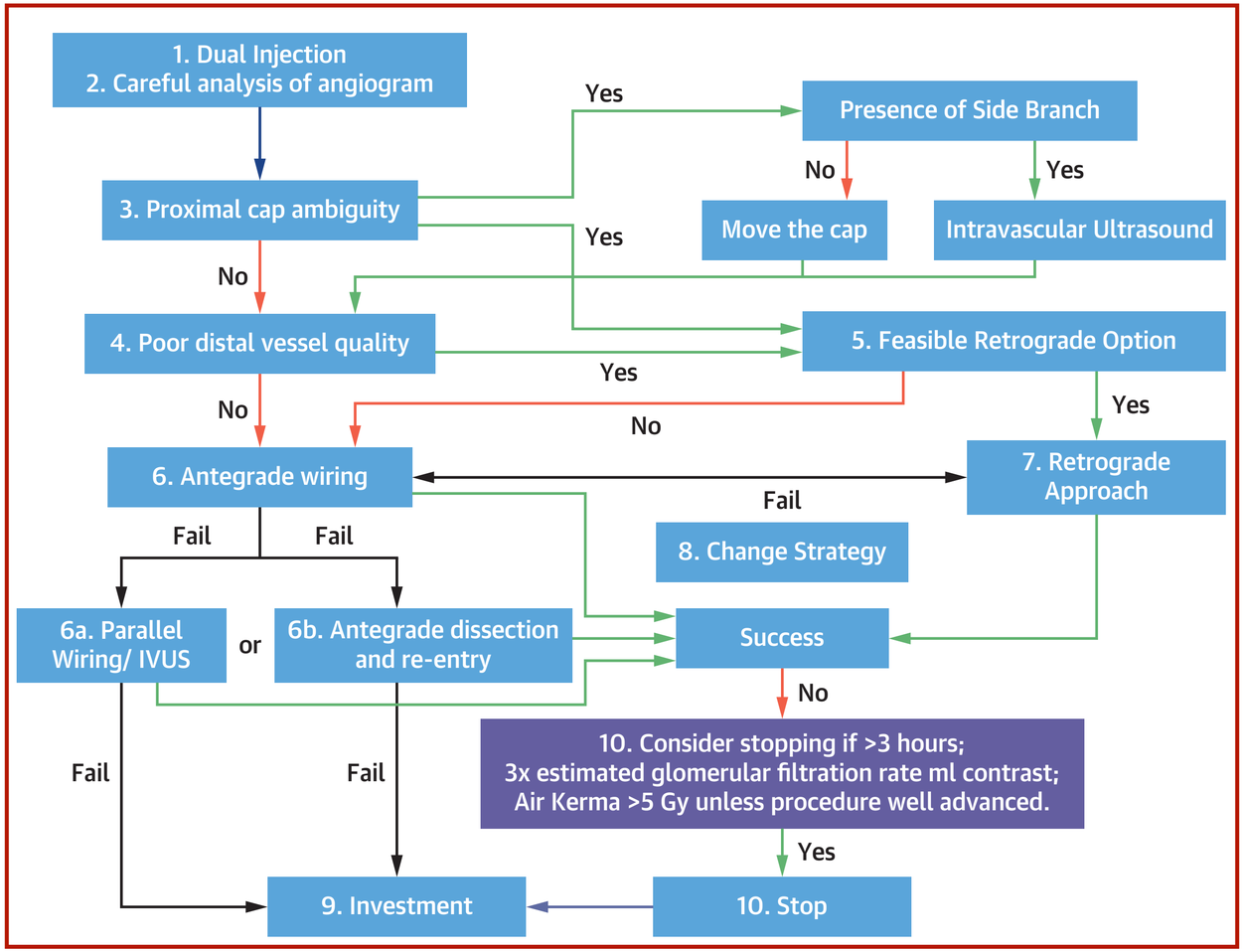


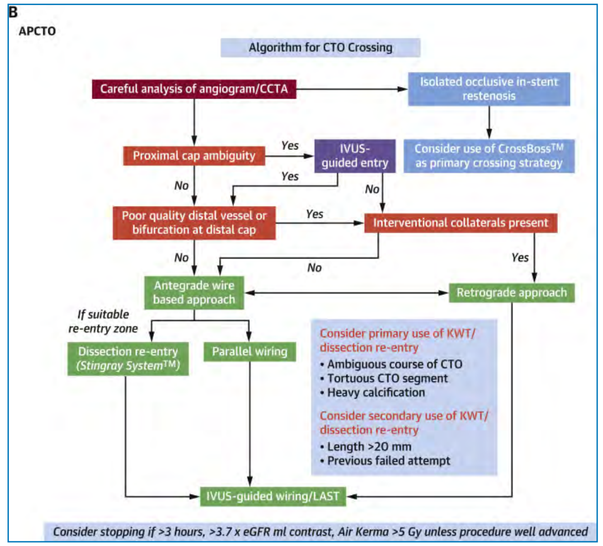
Maeremans J et al. JACC 2016;68:1958

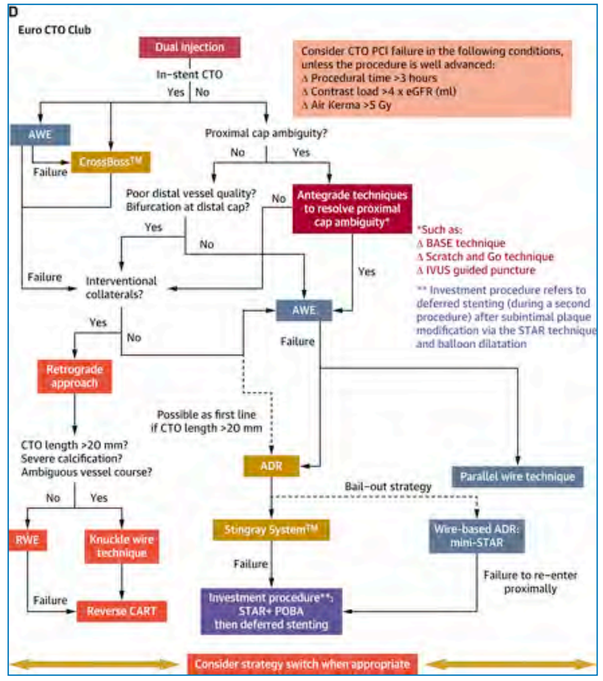
Algorithmen





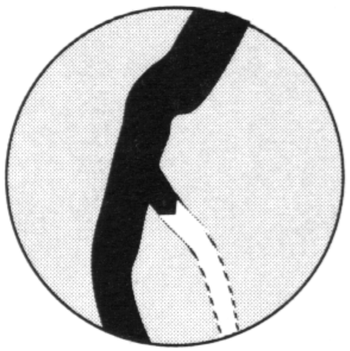




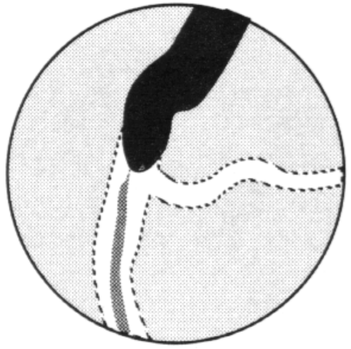


Prädiktoren - Morphologie

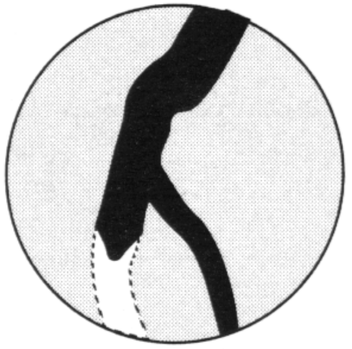
Favorable



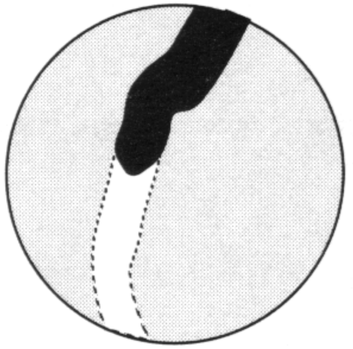
Tapered stump



Functional occlusion

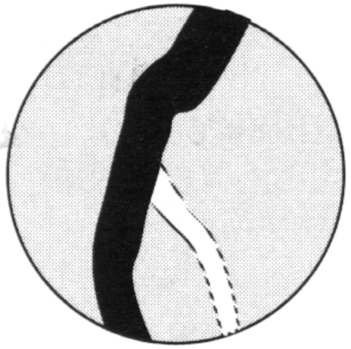


Pre or post-branch occl.

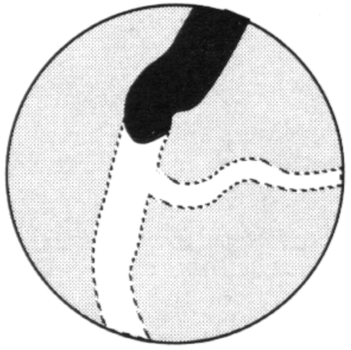


Bridging collaterals absent

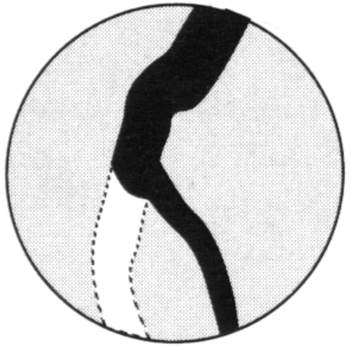
Unfavorable



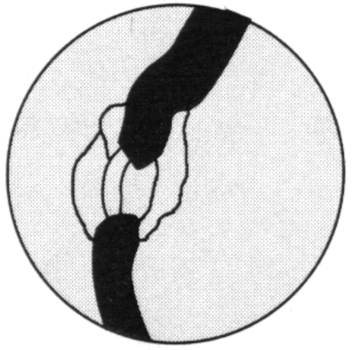
Stump absent



Total occlusion



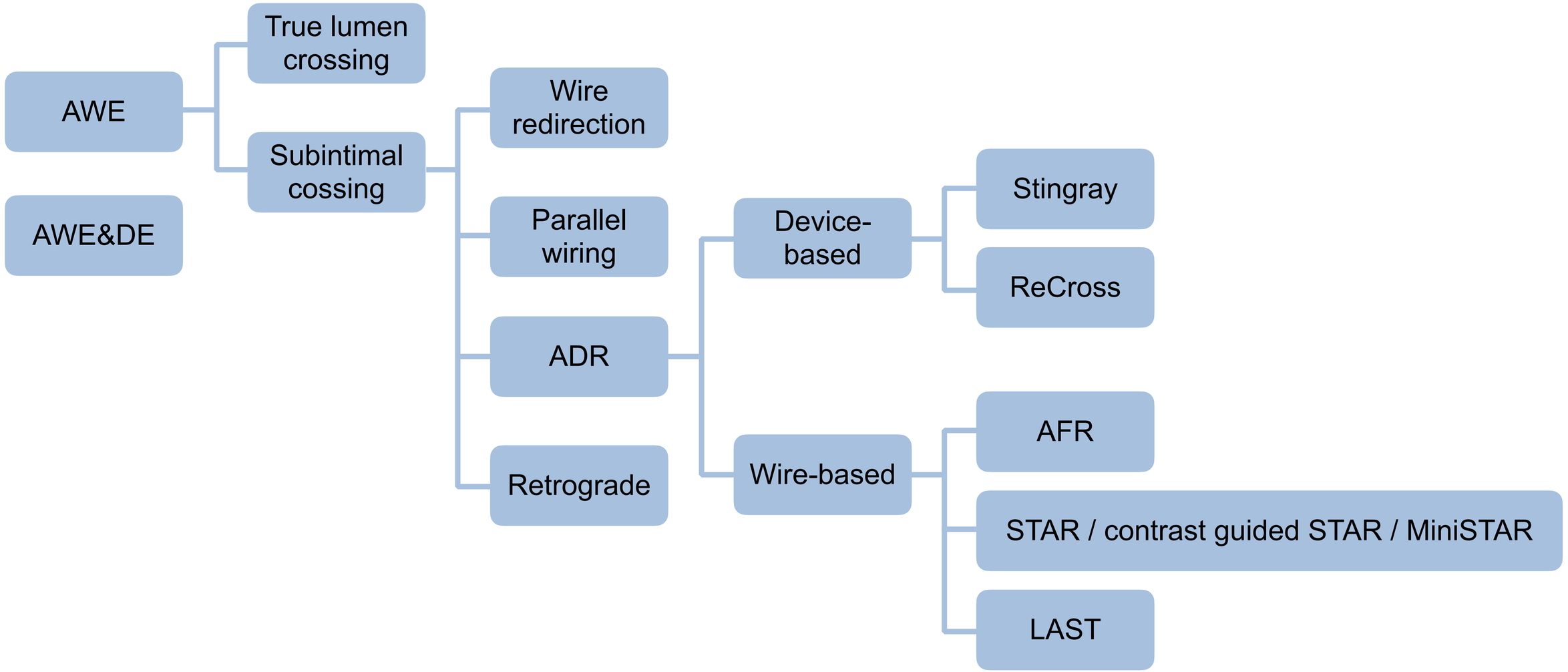
Occlusion at side-branch



Bridging collaterals present

Freed et al. Manual of Interventional Cardiology 1996

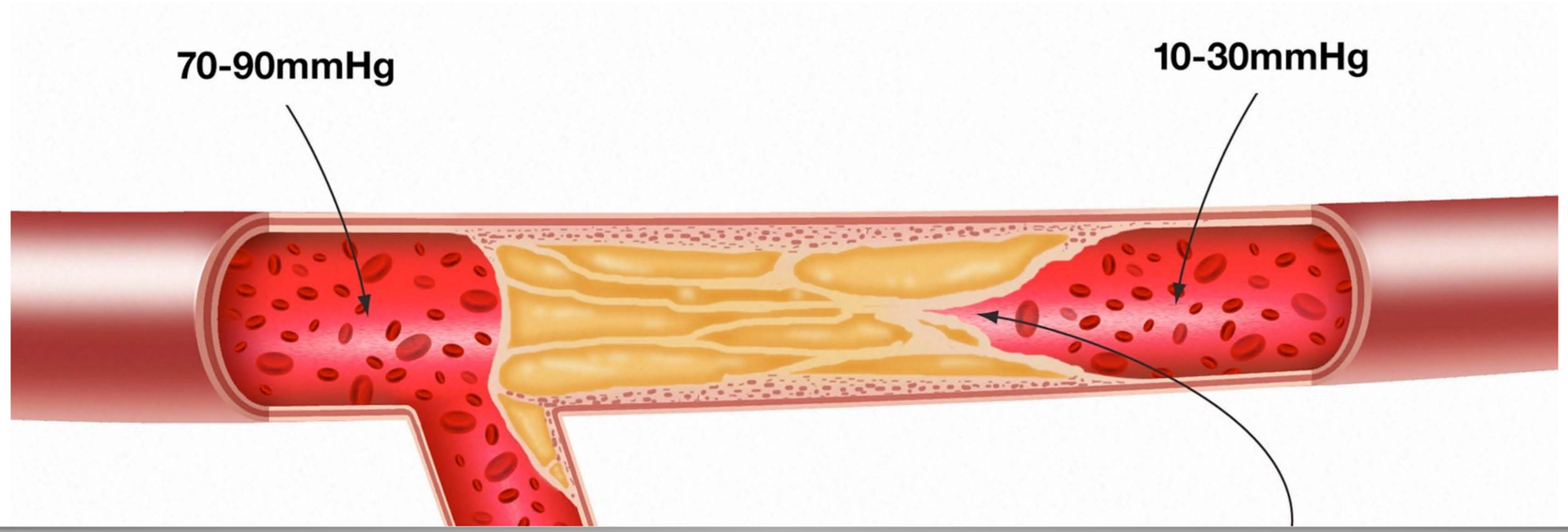
Antegrade Techniken



Adapted from Azzalini et al. Catheter Cardiovasc Interv. 2020 Apr 22. doi: 10.1002/ccd.28941.

Wieso Retrograd?

- proximale Verschlusskappe
  - dem arteriellen Druck ausgesetzt → härter, flach
- distale Verschlusskappe
  - dem kollateralen Druck ausgesetzt → weicher, Kanal



Werkzeuge

Specialty Guidewires

ASAHI Sion Blue

Key attributes: SION Tecc | Low tip load 0.5g | Hydrophobic tip | Hydrophilic spring coil

ASAHI RG3

Key attributes: Core-to-tip | Length 330cm | Hydrophilic coating 170cm

ASAHI Sion

Key attributes: SION Tecc | Low tip load 0.7g | Hydrophilic | 28cm spring coil

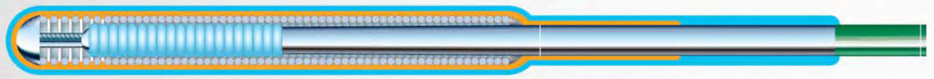
ASAHI Gaia First / Second / Third

Key attributes: SION Tecc | Pre-shaped 1mm microcone tip | Tapered spring coil | Hydrophilic coating | First – 1.7g, Second – 3.5g, Third – 4.5g

Fielder XT

Key attributes: Tapered polymer jacket | Low tip load 0.8g

SION Black



Key attributes: SION Tecc | Polymer jacket 20cm | Hydrophilic coating 40cm | Low tip load 0.8g

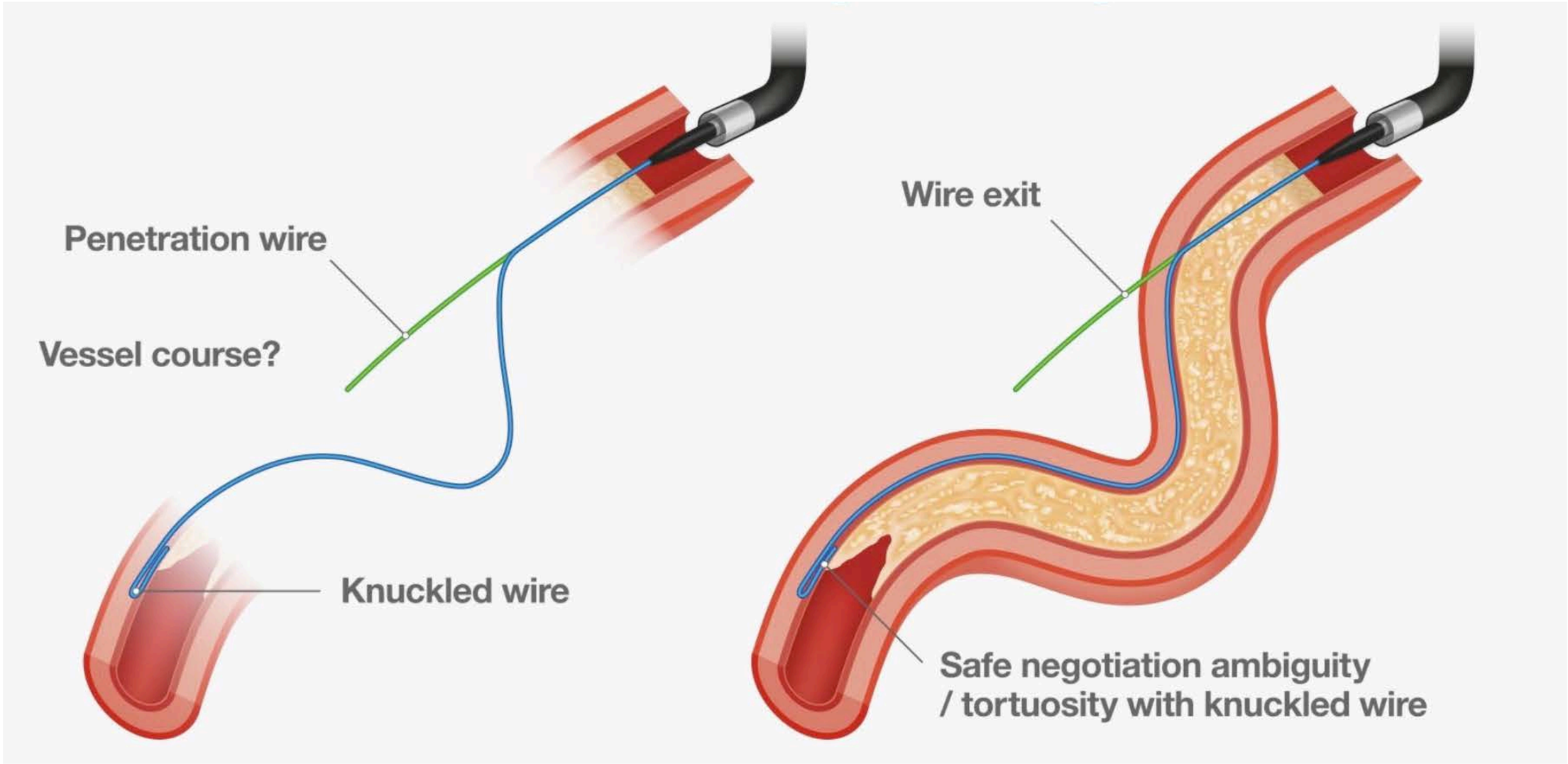
Fielder XT-R

Key attributes: SION Tecc | Tapered polymer jacket | Low tip load 0.6g

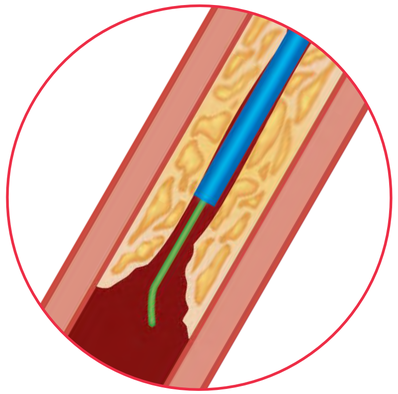
Pilot 200

Key attributes: Heavy tip load – 4.7g | Polymer jacket

Polymer coated knuckle wire

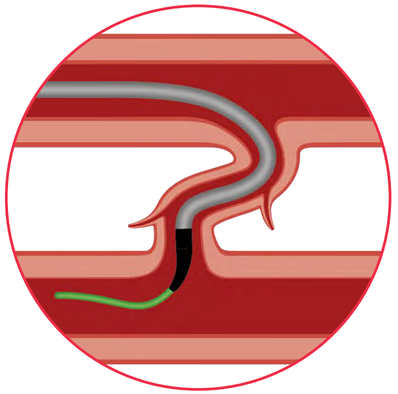


Microcatheter

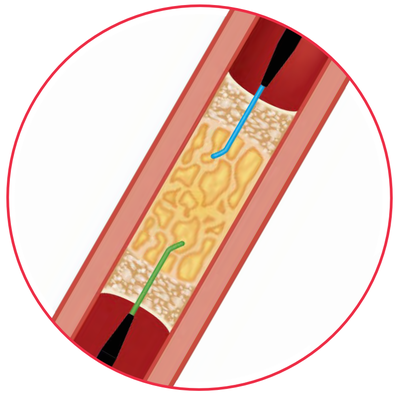


General Use
Finecross
SuperCross
Micro-14
Nhancer Pro

+++
Trackability

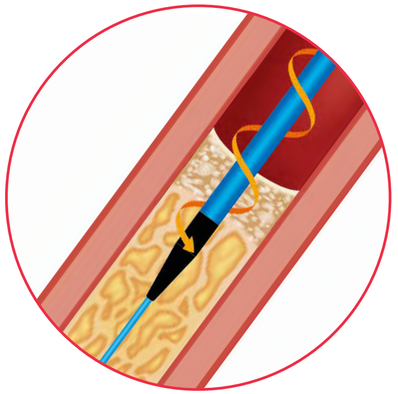


Retrograde
Fine collaterals
Caravel
Turnpike LP
Mamba Flex

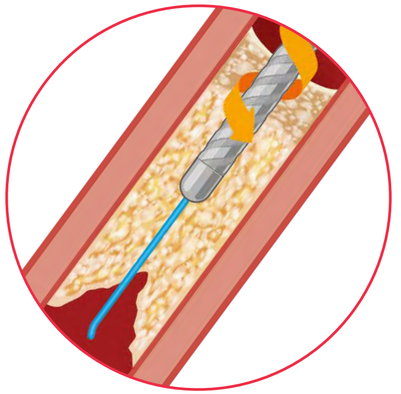


Retro & Antegrade
Corsair Pro
Turnpike
Teleport

+ +
Track & Push

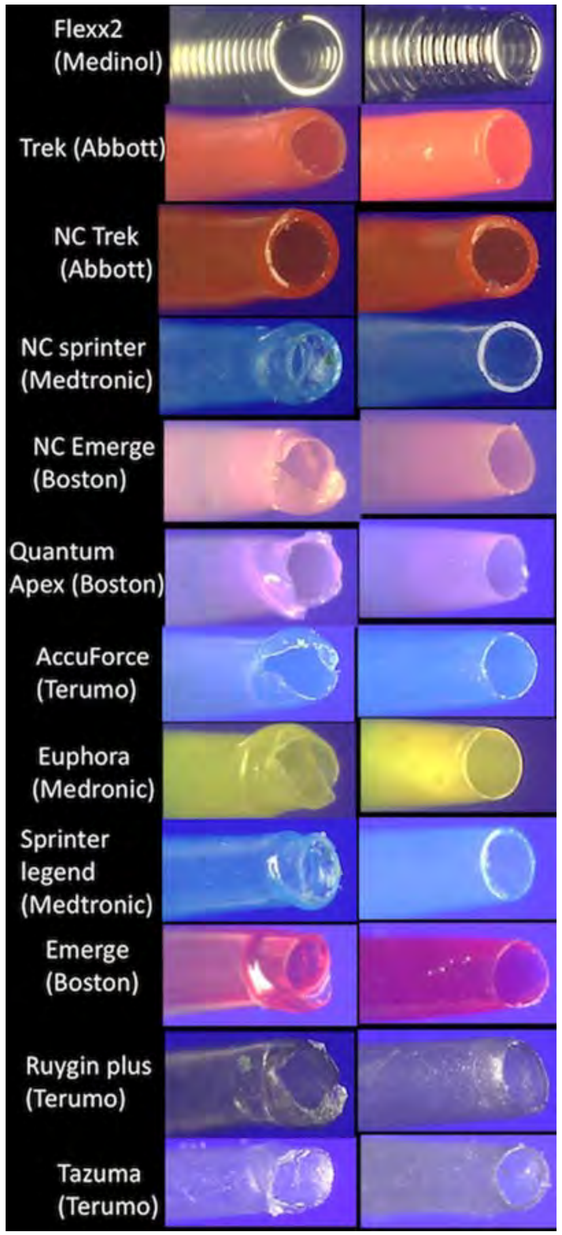


Antegrade
Turnpike Spiral
Mamba

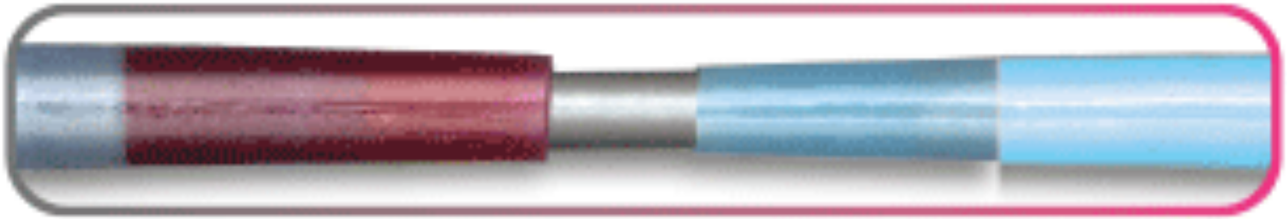


Ca+ Antegrade
Tornus
Turnpike Gold

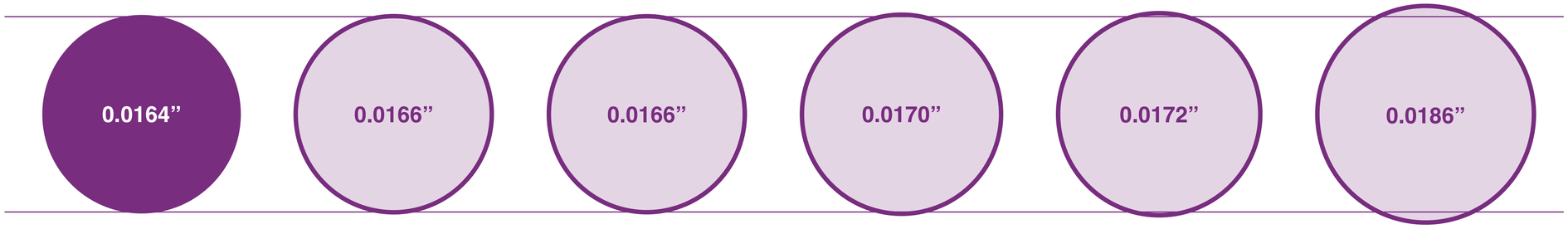
+++
Pushability



Low profile Balloons



Profiles



Sapphire II Pro
1.75 mm

Tazuna
1.25 mm

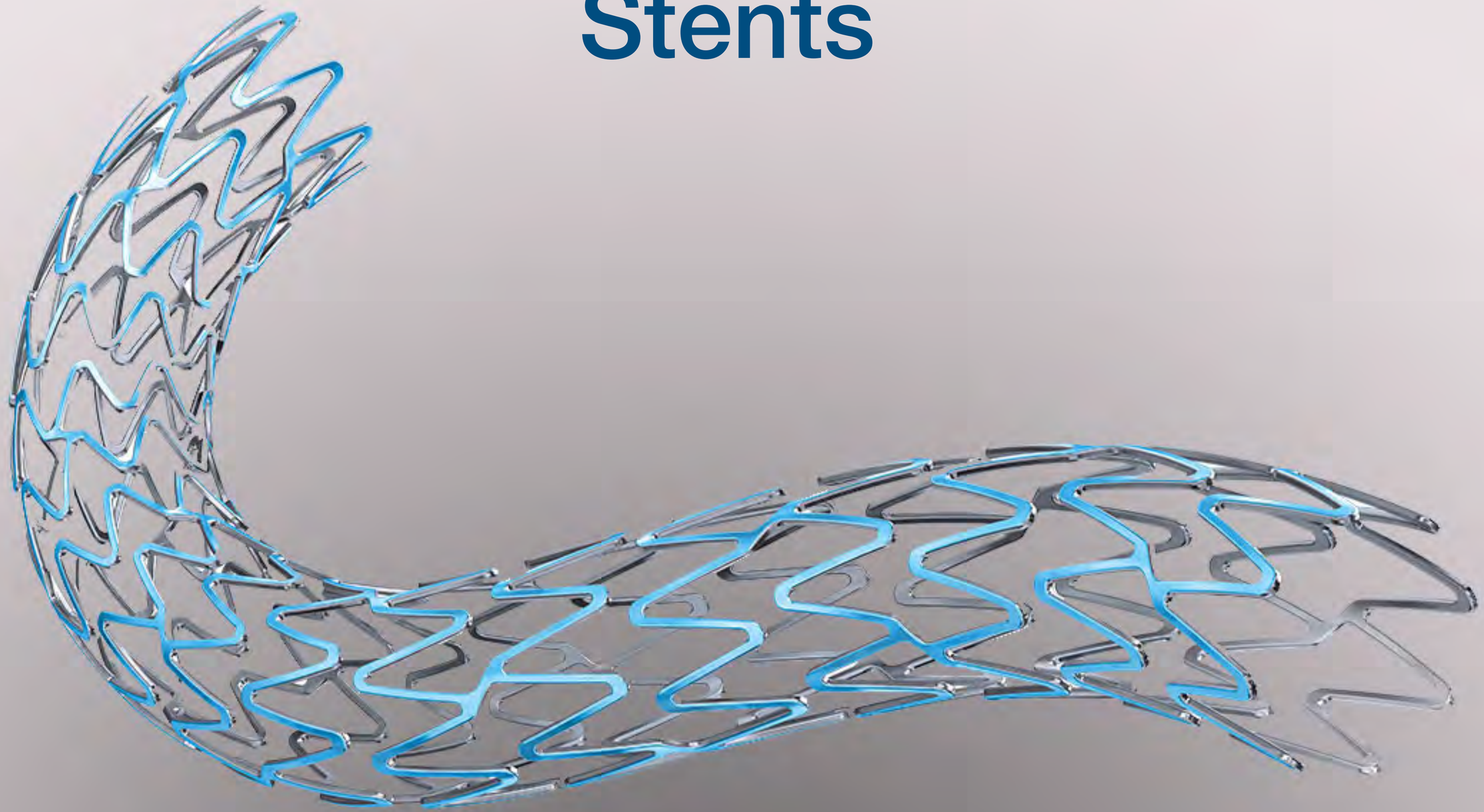
Lacrosse Laxa
1.3 mm

Emerge
1.2 mm

Across CTO
1.1 mm

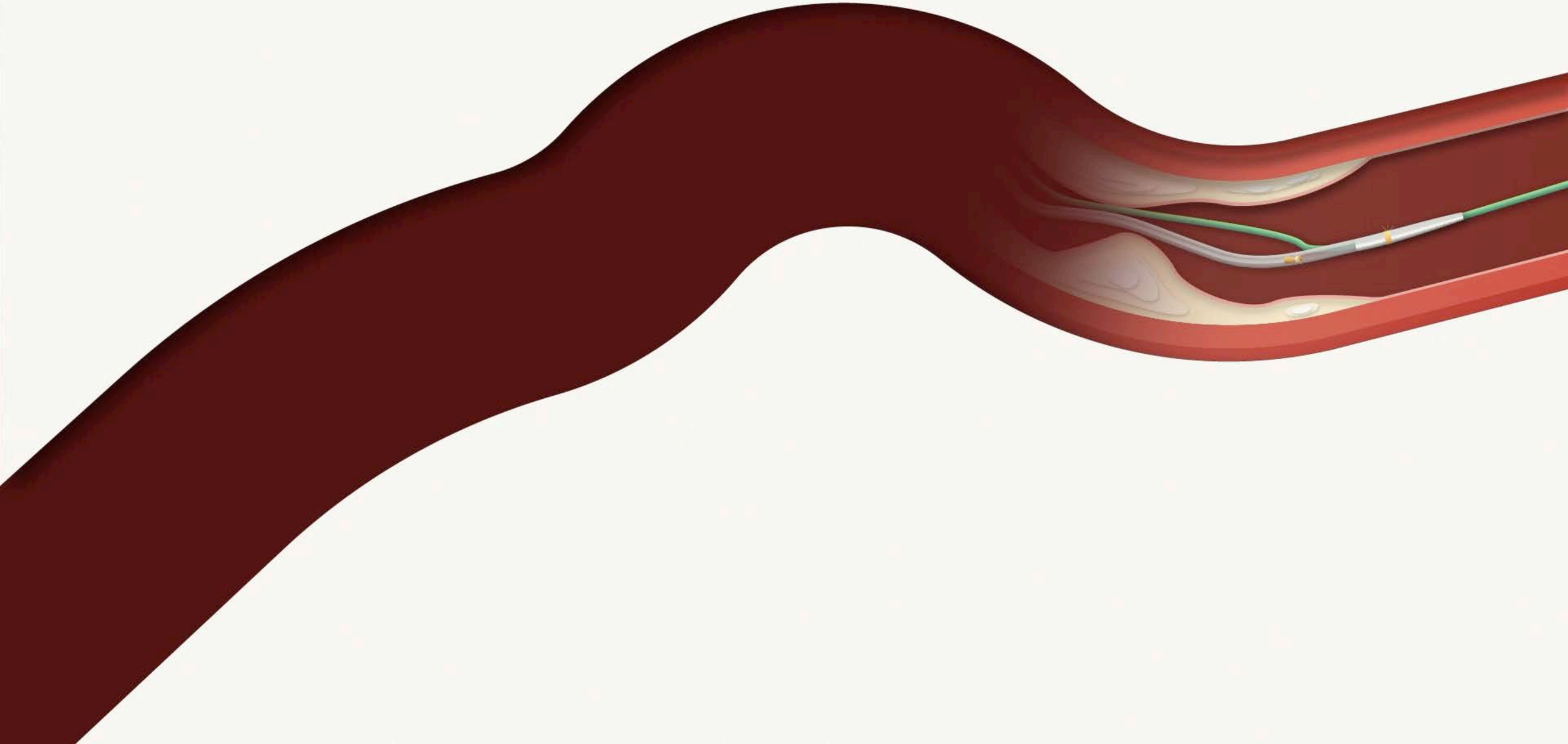
Mini Trek
1.2 mm

Stents

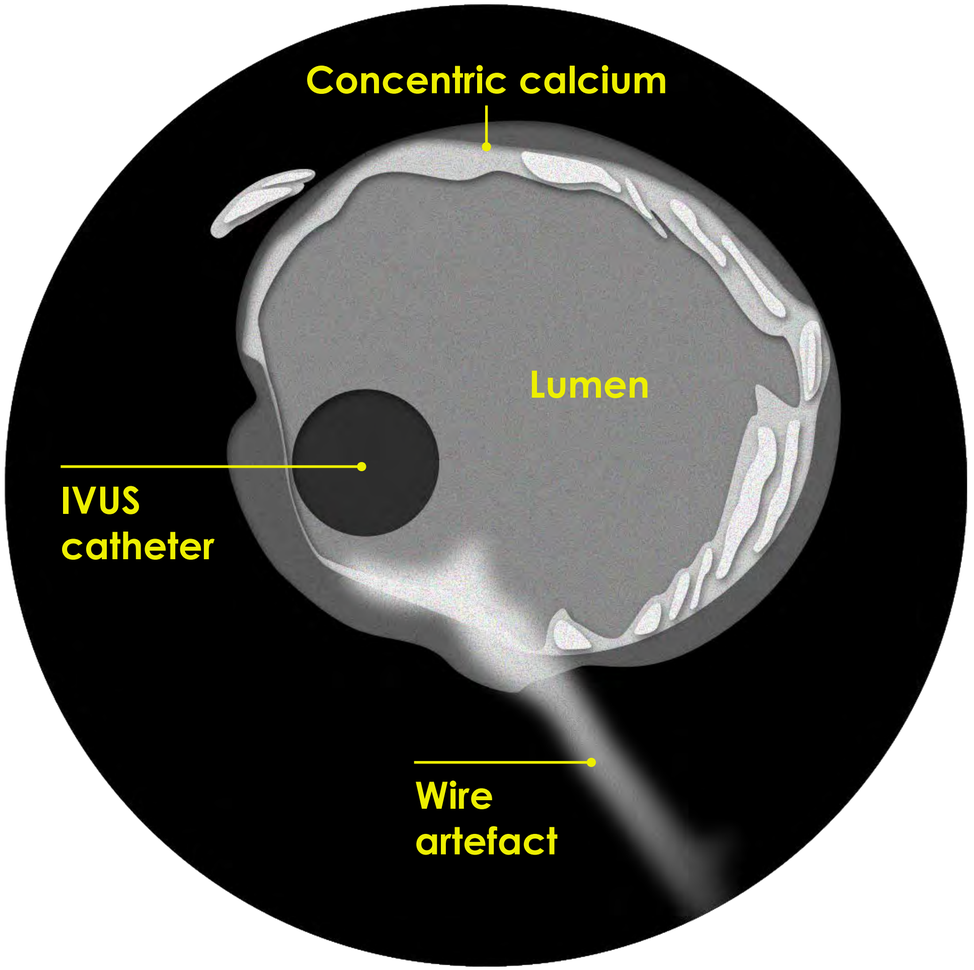


IVUS

IVUS is performed with a ‘pull-back’



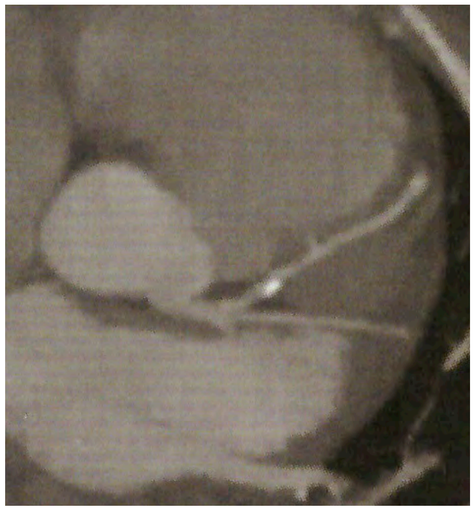
How can IVUS help?



Morphology – concentric calcification

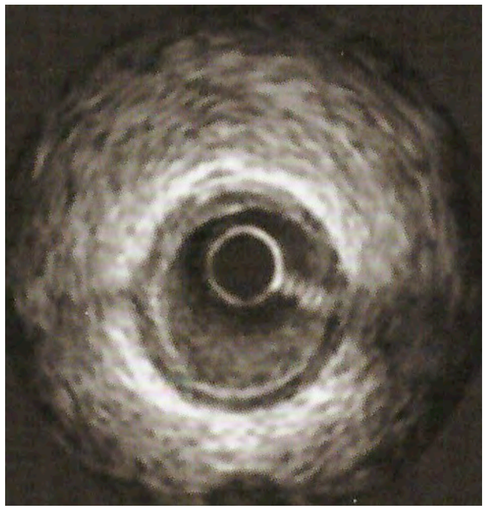
Imaging Resolution

CT-Angiography

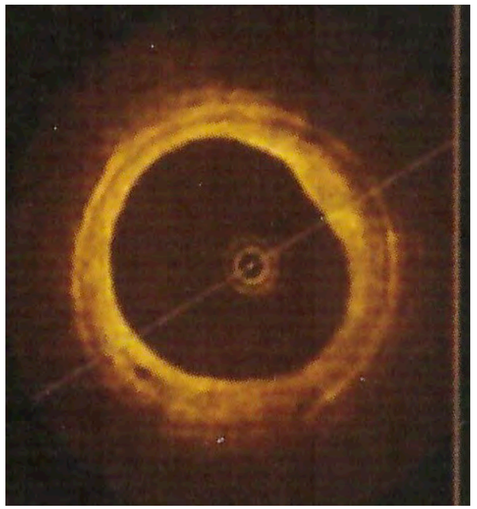


Angiography

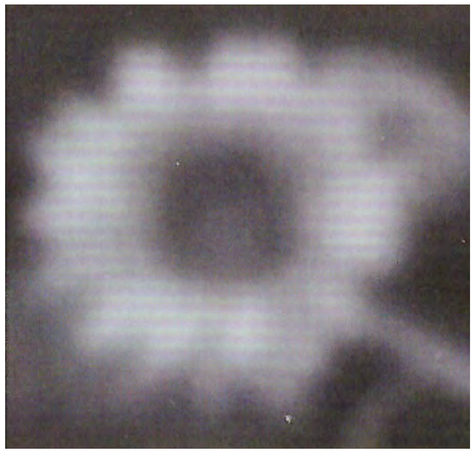
IVUS



OCT



600 µm



200 µm

100 µm

10 µm