The Trend of CTO PCI: Asia and Worldwide

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COI disclosure

- I, Shunsuke Matsuno have received honoraria for lecture from Asahi Intecc, Boston Scientific Japan, Orbus Neich Medical, and Abbott Medical Japan.

Various CTO PCI even in one country/region

This presentation:

1) will focus on the differences in CTO PCI between Japan and Europe/US
2) Is just my personal opinion

Today’s agenda

- Differences in CTO PCI between Japan and Europe/ US
- Recent procedural trends in Japan and Europe/ US
- Future perspectives of Japanese CTO PCI

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What’s the difference in CTO PCI?

- Patient and lesion characteristics
- Surrounding environment
- Operators’ skillset
- Operators’ mindset

CTO complexity is higher in Europe/US registries

Japan[1]

TABLE 1 Baseline Patient Characteristics and Baseline Angiographic Characteristics

	Overall (N = 2,596)	PAA (n = 1,872)	PRA (n = 724)	PAA vs. PRA p Value
Age, yrs	66.9 ± 10.9	66.8 ± 10.9	66.9 ± 10.7	0.863
BMI, kg/m^2	24.7 ± 3.8	24.7 ± 3.8	24.6 ± 3.8	0.413
LVEF	54.8 ± 12.9	54.9 ± 12.9	54.6 ± 12.8	0.458
eGFR	64.9 ± 29.0	65.1 ± 30.2	64.3 ± 25.7	0.458
Male	86.1	85.1	88.4	0.018
Hypertension	78.5	78.0	80.8	0.12
Dyslipidemia	77.5	76.1	82.1	0.001
Diabetes	44.9	44.9	45.8	0.35
Current smoking	54.4	58.0	62.3	0.057
OMI	51.0	51.7	51.3	0.895
Prior CABG	7.9	7.4	9.4	0.105
Prior PCI	63.2	61.8	67.5	0.007
Reattempt	20.6	15.1	34.8	<0.0001
Syntax score	15.9 ± 8.6	16.0 ± 8.4	15.6 ± 8.9	0.062
J-CTO score	2.0 ± 1.1	1.9 ± 1.1	2.4 ± 1.1	<0.0001
Number of diseased vessels				0.015
Single VD	49.1	50.6	45.1	
Double VD	30.1	28.8	33.5	
Triple VD	17.1	17.3	16.6	
LMT + multiple VD	3.8	3.3	4.9	
Target vessel				<0.0001
LAD	30.9	32.9	25.7	
LCX	17.1	20.4	8.6	
LMT	0.6	0.6	0.6	
RCA	51.5	46.2	65.2	
In-stent occlusion	13.6	16.9	5.1	<0.0001
Distal runoff <3.0 mm	65.0	64.9	67.2	0.274
CTO length ≥20 mm	60.5	57.0	69.6	<0.0001
Side branch at proximal cap	34.1	34.8	32.0	0.181
Collateral filling				<0.0001
Contralateral	50.7	47.6	58.8	
Ipsilateral	13.3	15.9	6.6	
Both	35.2	35.5	34.4	
None	0.7	1.0	0.1	
Lesion calcification	52.3	50.5	56.9	0.003
Proximal tortuosity	50.7	49.1	49.3	0.108
Tortuosity of CTO lesion	24.6	21.6	32.5	<0.0001
Morphology of proximal cap				0.002
Blunt	23.7	23.6	23.9	
No stump	19.1	17.7	22.7	
Tapered/tunnel	56.7	58.3	52.3	

US[2]

TABLE 1 Clinical Characteristics of the Study Population, Classified According to Technical Success

	Overall (N = 3,055)	Technical Success (n = 2,657)	Technical Failure (n = 398)	p Value
Age (yrs)	64.80 ± 10.09	64.6 ± 10.15	66.01 ± 9.63	0.0141
Male	85.25	84.69	88.95	0.0378
BMI (kg/m^2)	30.60 ± 6.14	30.50 ± 6.15	31.20 ± 6.02	0.0666
Smoking (current)	26.01	25.37	30.27	0.0561
Diabetes	43.02	43.53	39.65	0.1758
Dyslipidemia	92.20	92.11	92.75	0.6781
Hypertension	90.26	89.61	94.49	0.0044
Family history of CAD	33.35	33.44	32.80	0.8423
CCS angina classification				0.4771
Class ≤1	11.44	11.64	10.15	
Class ≥2	88.56	88.36	89.85	
Myocardial viability performed	24.99	24.28	29.32	0.0783
Prior MI	46.00	44.82	53.75	0.0023
Heart failure	30.56	29.71	36.25	0.0159
Prior valve surgery or procedure	3.17	3.06	3.89	0.4210
Prior PCI	65.29	64.49	70.62	0.0180
Prior CABG surgery	32.49	31.28	40.68	0.0003
Baseline creatinine (mg/dl)	1.01 (0.89-1.22)	1.01 (0.89-1.21)	1.07 (0.90-1.27)	0.1301
Currently on dialysis	2.67	2.50	3.80	0.1633
Prior CVD	11.70	11.51	12.90	0.4567
Prior PAD	15.02	14.53	18.29	0.0709
Chronic lung disease	14.20	13.80	16.81	0.1386
Left ventricular EF (%)	54 (42-60)	55 (44-60)	50 (40-60)	0.0357

TABLE 2 Angiographic Characteristics of Study Lesions, Classified According to Technical Success

	Overall (N = 3,122)	Technical Success (n = 2,711)	Technical Failure (n = 411)	p Value
Target vessel				0.0640
RCA	55.22	54.93	57.14	
LAD	23.81	24.57	18.80	
LCx	19.91	19.47	22.81	
Other	1.06	1.03	1.25	
CTO length (mm)	33.99 ± 24.16	33.43 ± 24.14	37.80 ± 23.99	0.0030
Vessel diameter (mm)	2.85 ± 0.51	2.86 ± 0.51	2.81 ± 0.47	0.1383
Proximal cap ambiguity	35.06	31.98	53.97	<0.0001
Side branch at proximal cap	49.91	47.56	64.14	<0.0001
Blunt stump/no stump	53.69	50.61	72.55	<0.0001
Interventional collateral vessels	56.72	58.80	44.19	<0.0001
Moderate/severe calcification	54.23	52.30	67.02	<0.0001
Moderate/severe tortuosity	34.96	33.43	45.21	<0.0001
In-stent restenosis	16.61	16.13	19.68	0.0878
Previously failed CTO PCI	20.20	19.21	26.70	0.0005
J-CTO score	2.43 ± 1.30	2.34 ± 1.29	3.07 ± 1.13	<0.0001
PROGRESS CTO score	1.32 ± 1.03	1.25 ± 1.01	1.77 ± 1.01	<0.0001
PROGRESS CTO complication score	3.07 ± 1.93	3.00 ± 1.91	3.54 ± 1.97	<0.0001

Aggressive techniques are more likely to be needed.

1. Suzuki Y, et al. JACC Cardiovasc Interv. 2017;10:2144-2154., 2. Tajti P, et al. JACC Cardiovasc Interv. 2018;11:1325-1335.

What’s the difference in CTO PCI?

- Patient and lesion characteristics
- Surrounding environment
- Operators’ skillset
- Operators’ mindset

Japanese operators are in unique environment

- Reimbursement for IVUS and CT
- Wide and easy accessibility to CT
- Availability of CTO-dedicated novel equipment
- Lower cath lab pressure
- Lower BMI patients who tolerate longer fluoroscopy time

How about European and US operators?

- Lack of or limited availability of IVUS/ CT
- Need for shorter procedure time (many cases per cath lab, higher BMI)

↓

Different techniques (knuckling, move-the-cap technique, and wire-based/ device-based ADR) have been adopted to treat complex CTO safely and efficiently.

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Preference or obsession w/ intraplaque wiring

Japanese operators tend to have excessive concern about longer stent length, side branch loss, and vessel trauma

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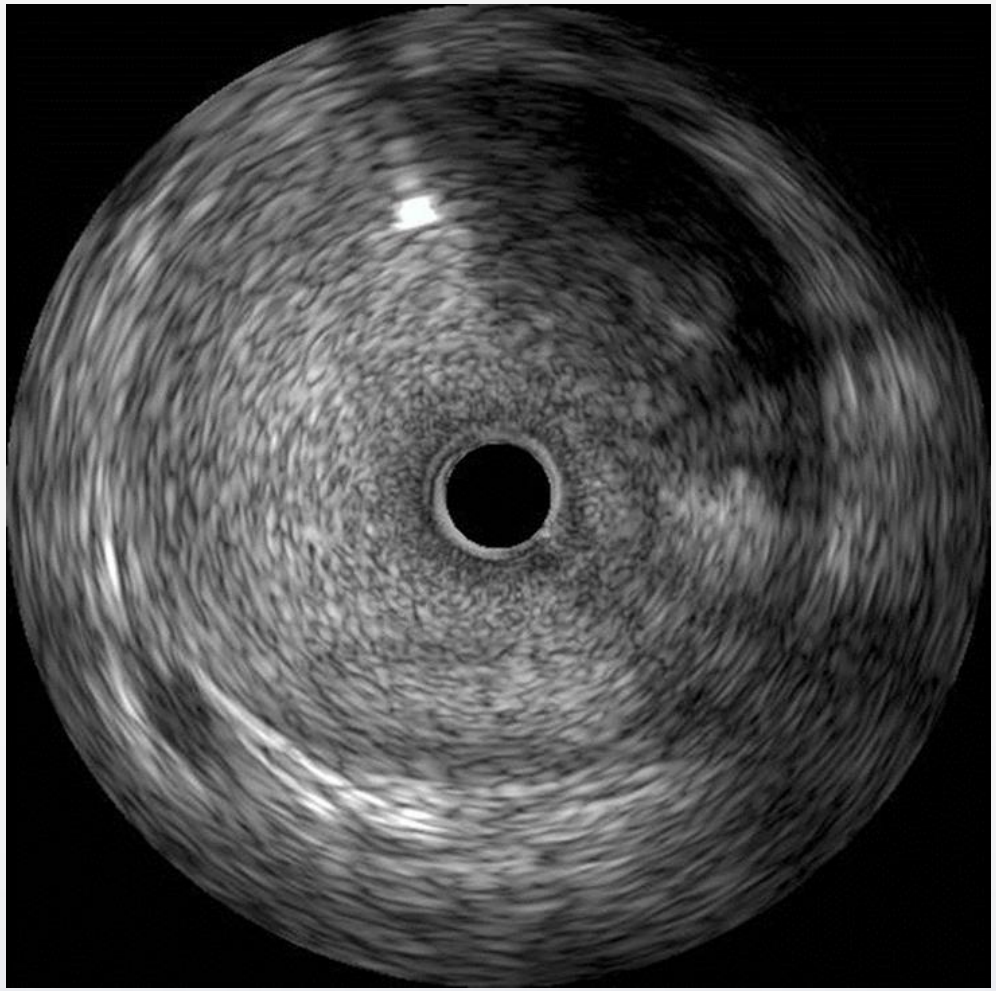
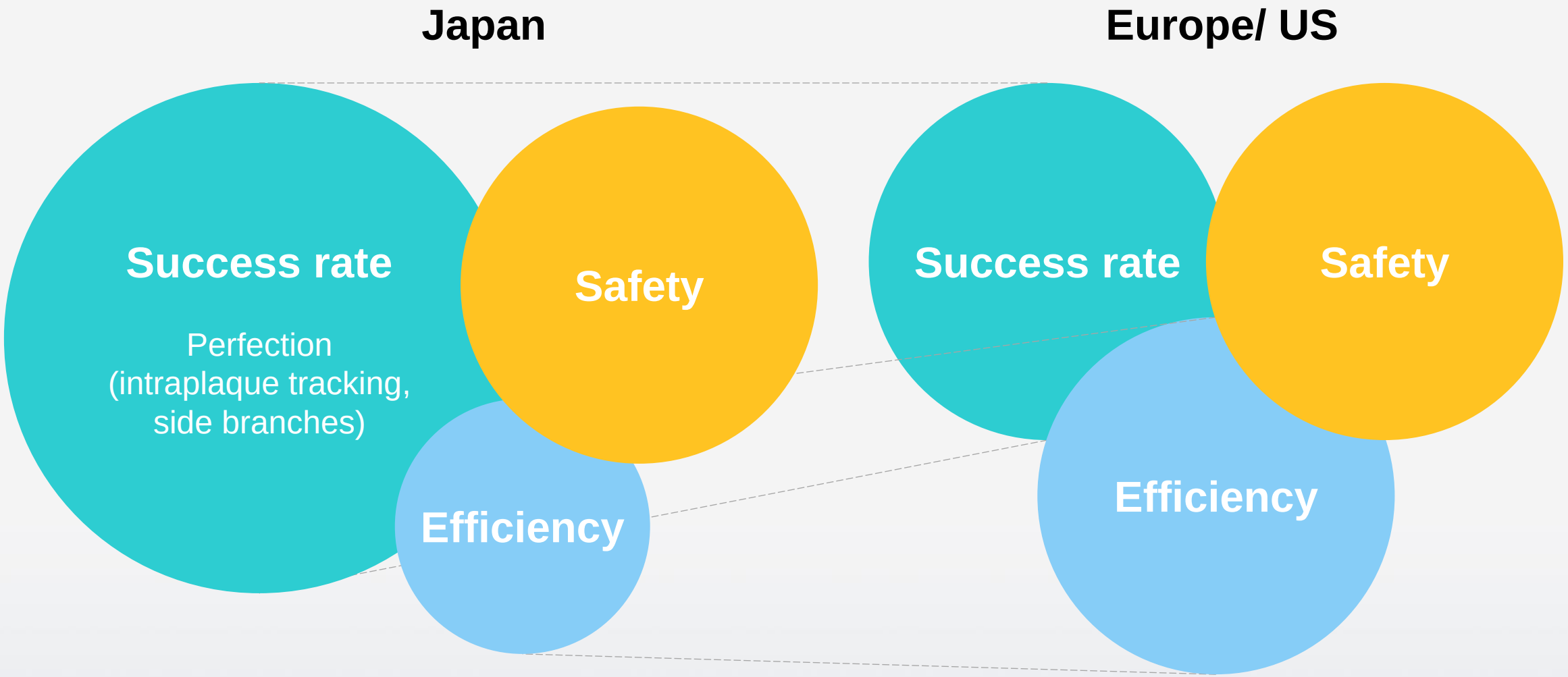
Conventional wiring that is more likely to stay within the intraplaque space has been prioritized (= **rejection of the extraplaque tracking techniques**).



Difference in priorities in CTO PCI



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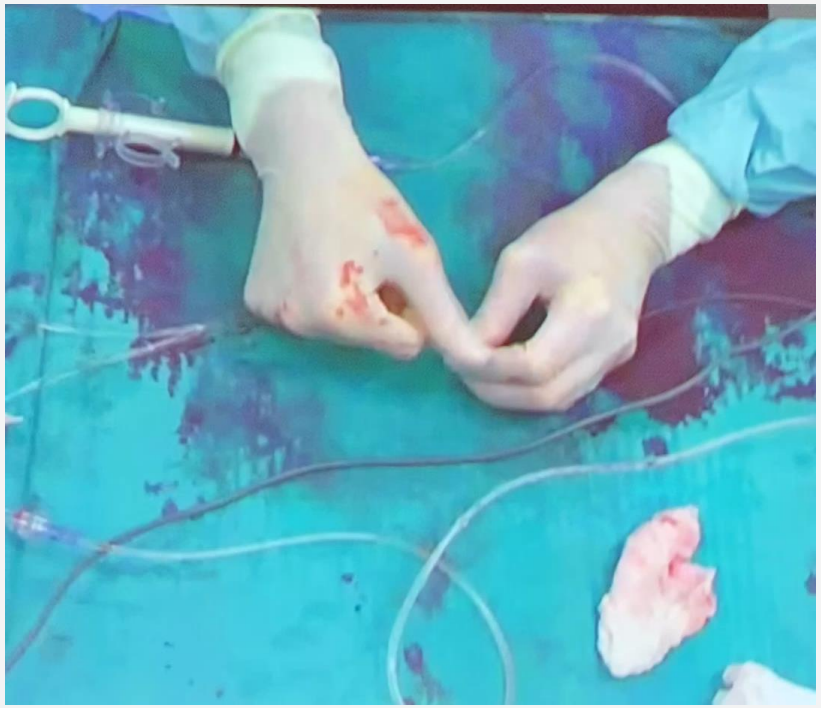
- Operators' skillset

Wire manipulation methods are different

Japanese operator (me)

Delicate and slow

Some European operator



Aggressive and quick

Familiarity with imaging-guided wiring in Japan

- IVUS/ CT guidance or retrograde approach is preferred for the ambiguous proximal cap, and BASE/ Scratch and Go techniques are rarely selected.
- Not knuckling but conventional wiring is attempted based on IVUS/ CT information even in long CTO.
- The threshold for IVUS use is very low for the intraplaque rewiring, the reentry from the extraplaque space, and the difficult reverse CART.
- Tend to be unfamiliar with knuckling, move-the-cap techniques, Stingray.

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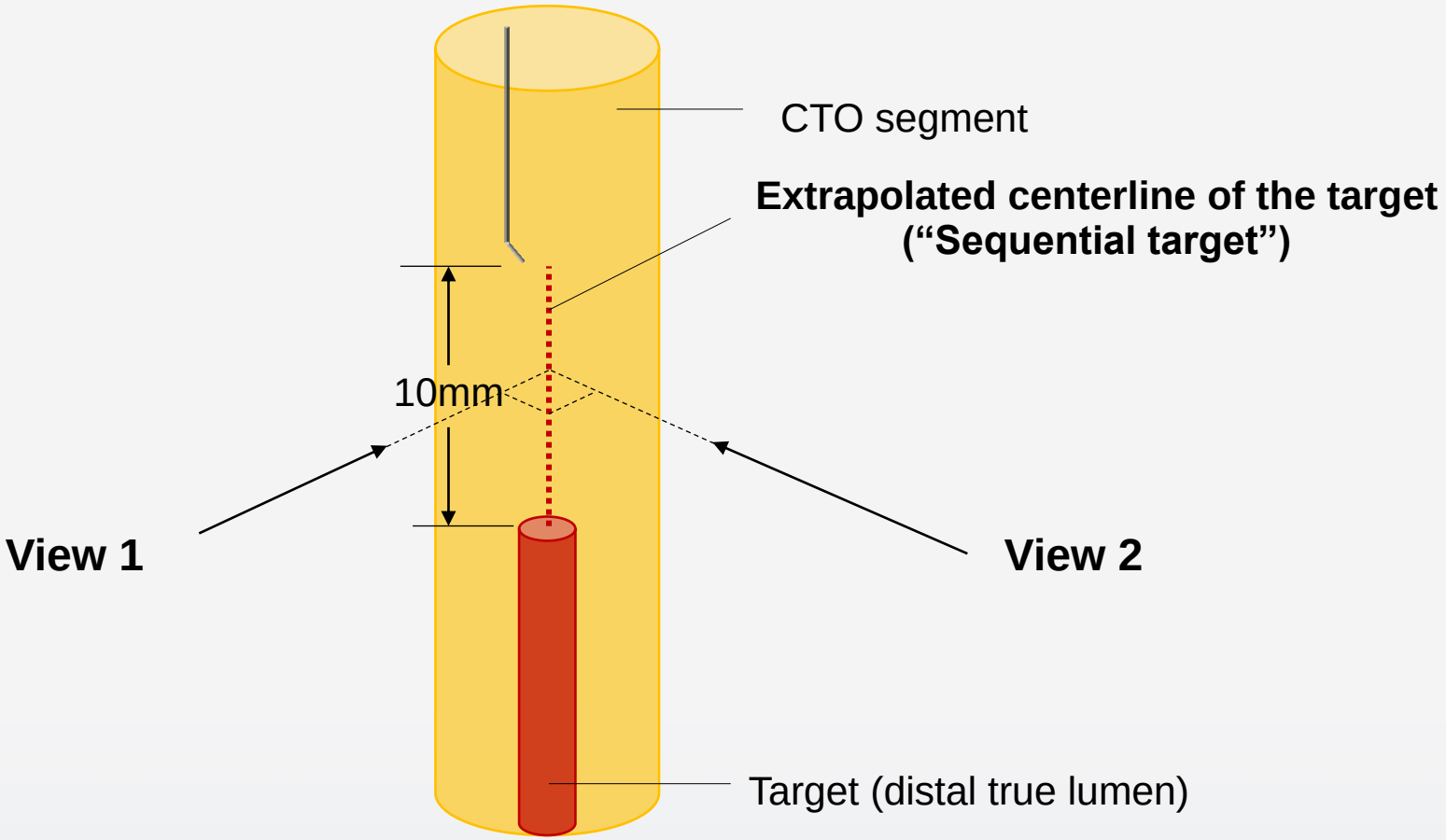
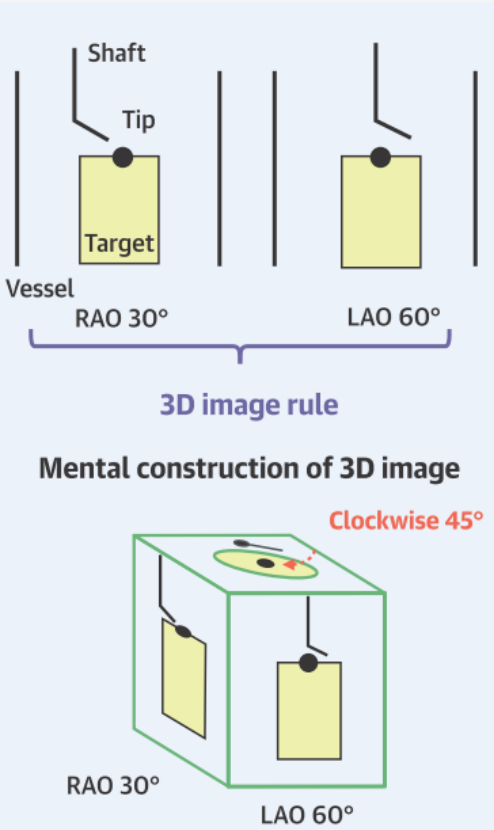
Recent trends in Japanese CTO PCI

- **Reconsideration of the importance of the antegrade approach**
  - ✓ Proposal of reliable and reproducible wire manipulation methods
  - ✓ Development of novel IVUS-guided wiring

Concept of the angiography-guided 3D wiring





"Attempt to control the wire trajectory as a 3-dimensional curve"

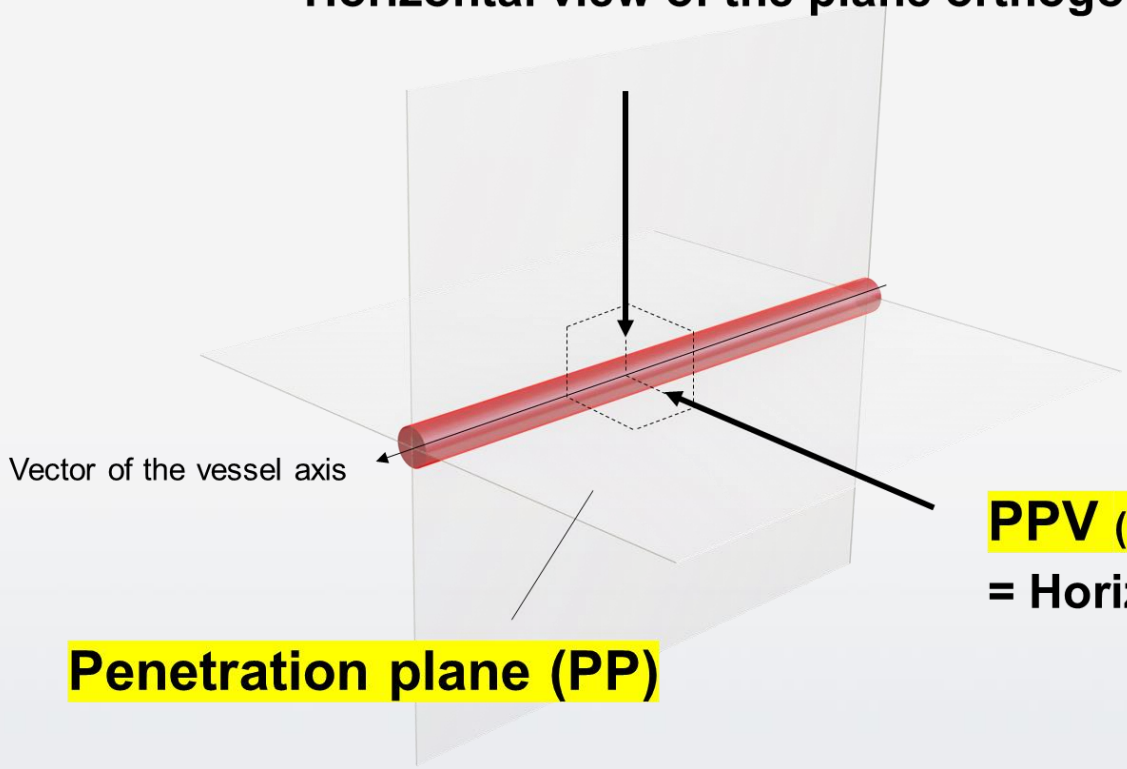
Okamura A, et al. JACC Cardiovasc Interv. 2020 Jan 13;13(1):74-82.

Penetration plane (PP) method

Wire manipulation method aiming to make a 3D wire control simpler and reproducible by keeping a wire track curve on a plane

OPV (objective perpendicular view)

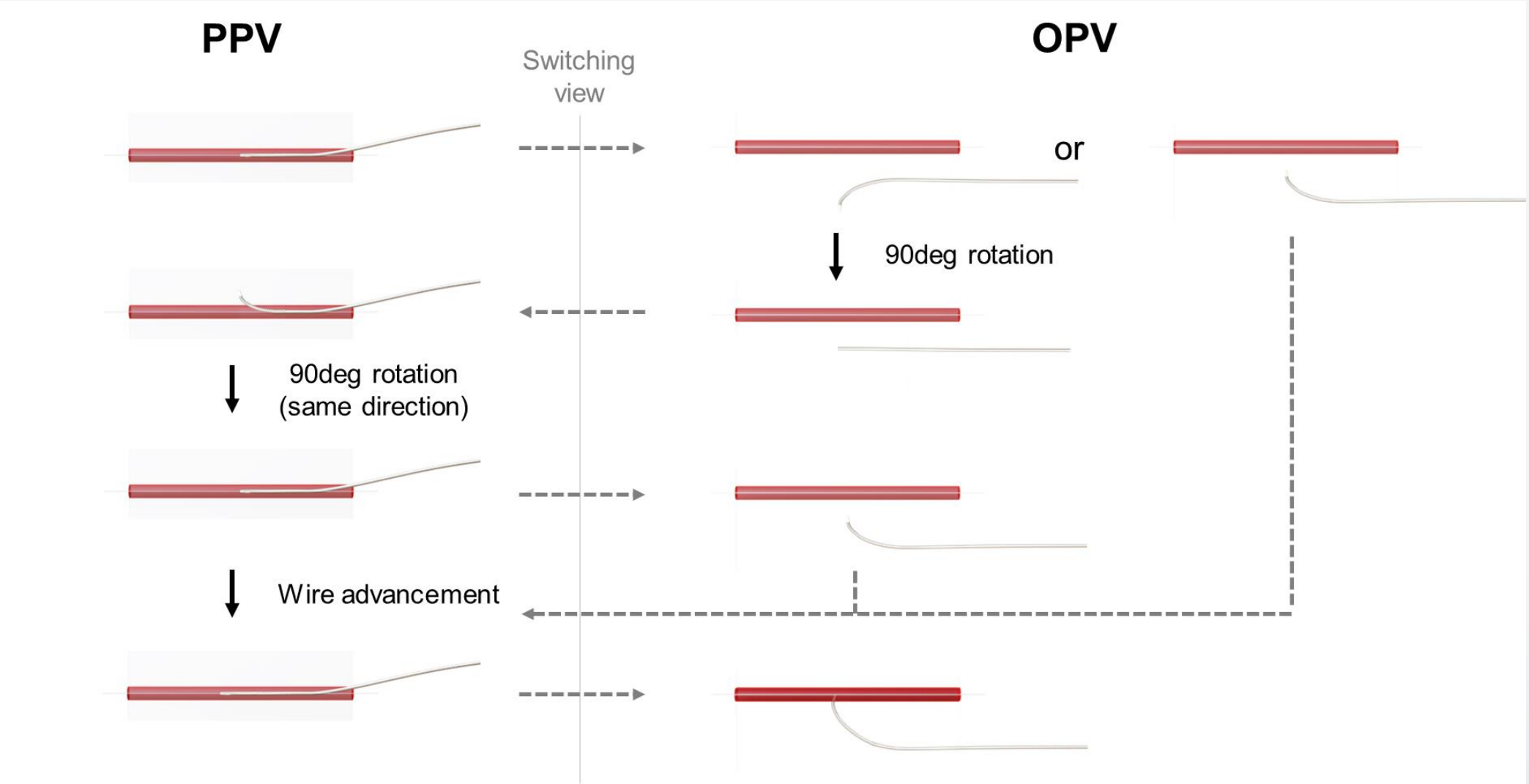
= Horizontal view of the plane orthogonal to the PP



PPV (penetration plane view)

= Horizontal view of the PP

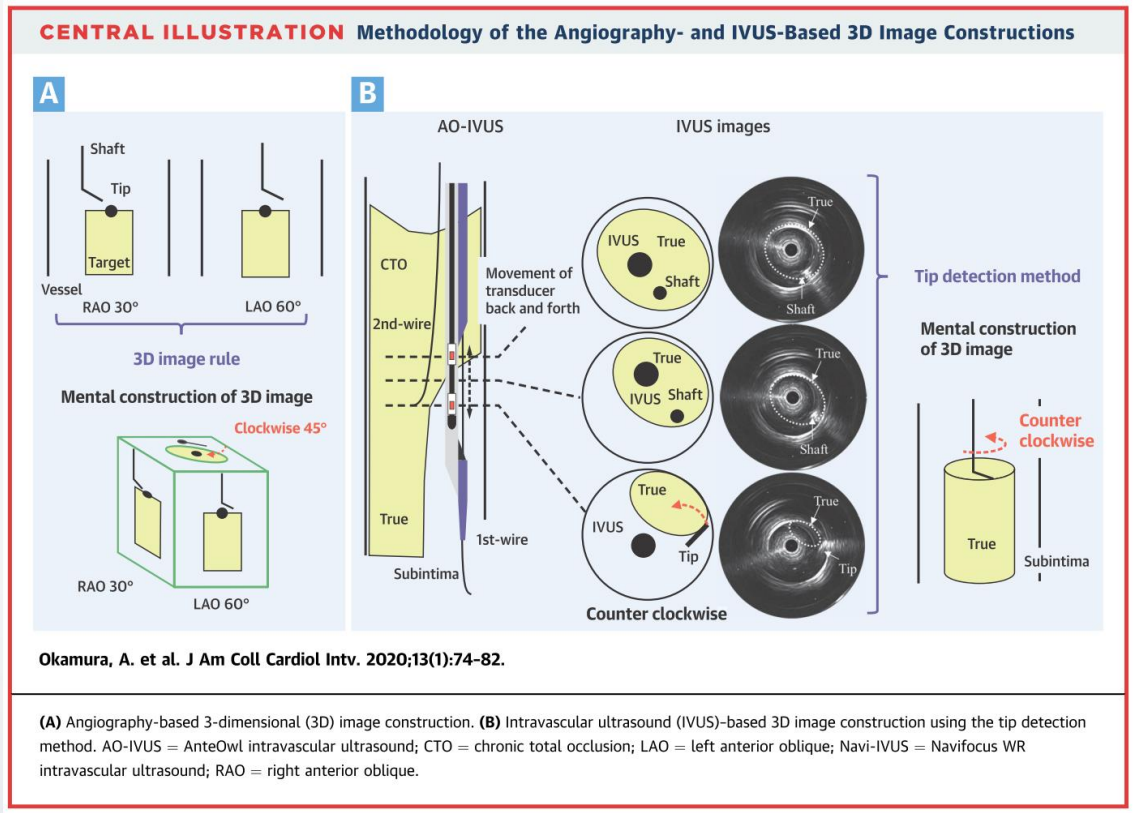
PP method wiring



Tip detection (TD) method using AnteOwl IVUS

Real-time visualization of wire tip, shaft, and target during wire manipulation helps to construct a 3D image of the wire trajectory toward the target.

TD- intraplaque rewiring



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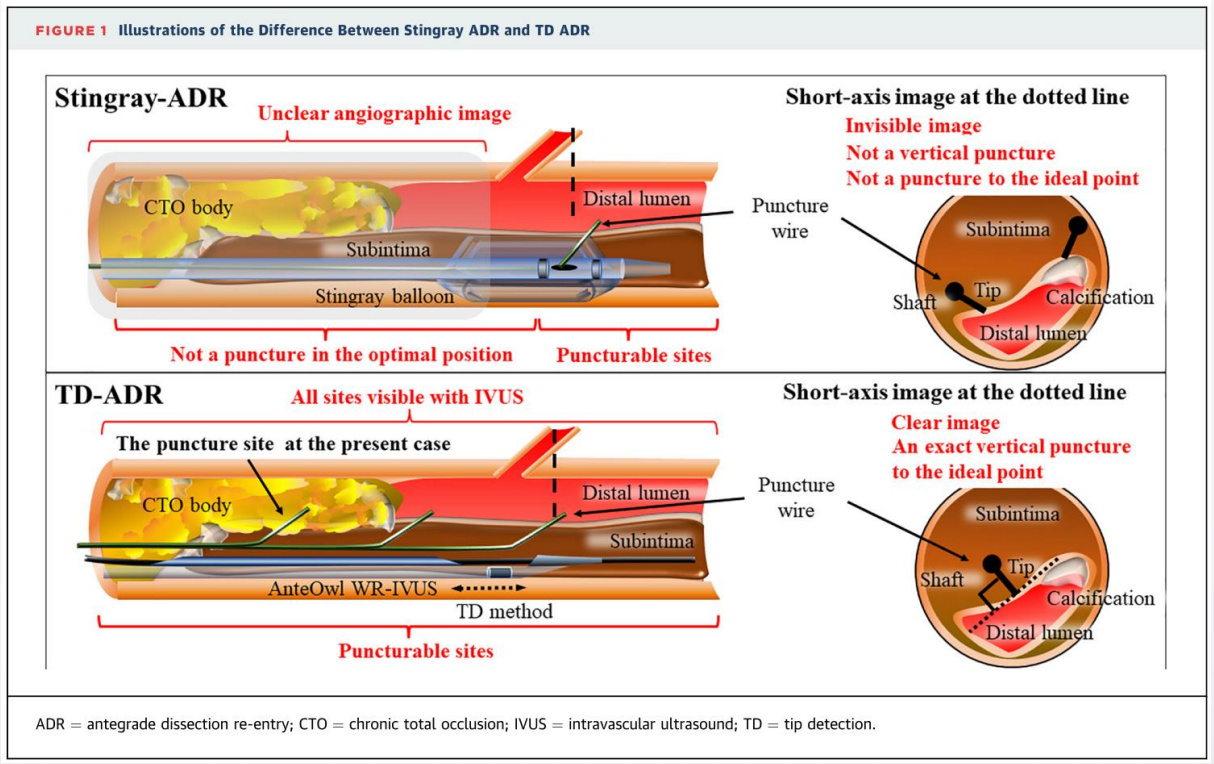
TD- ADR

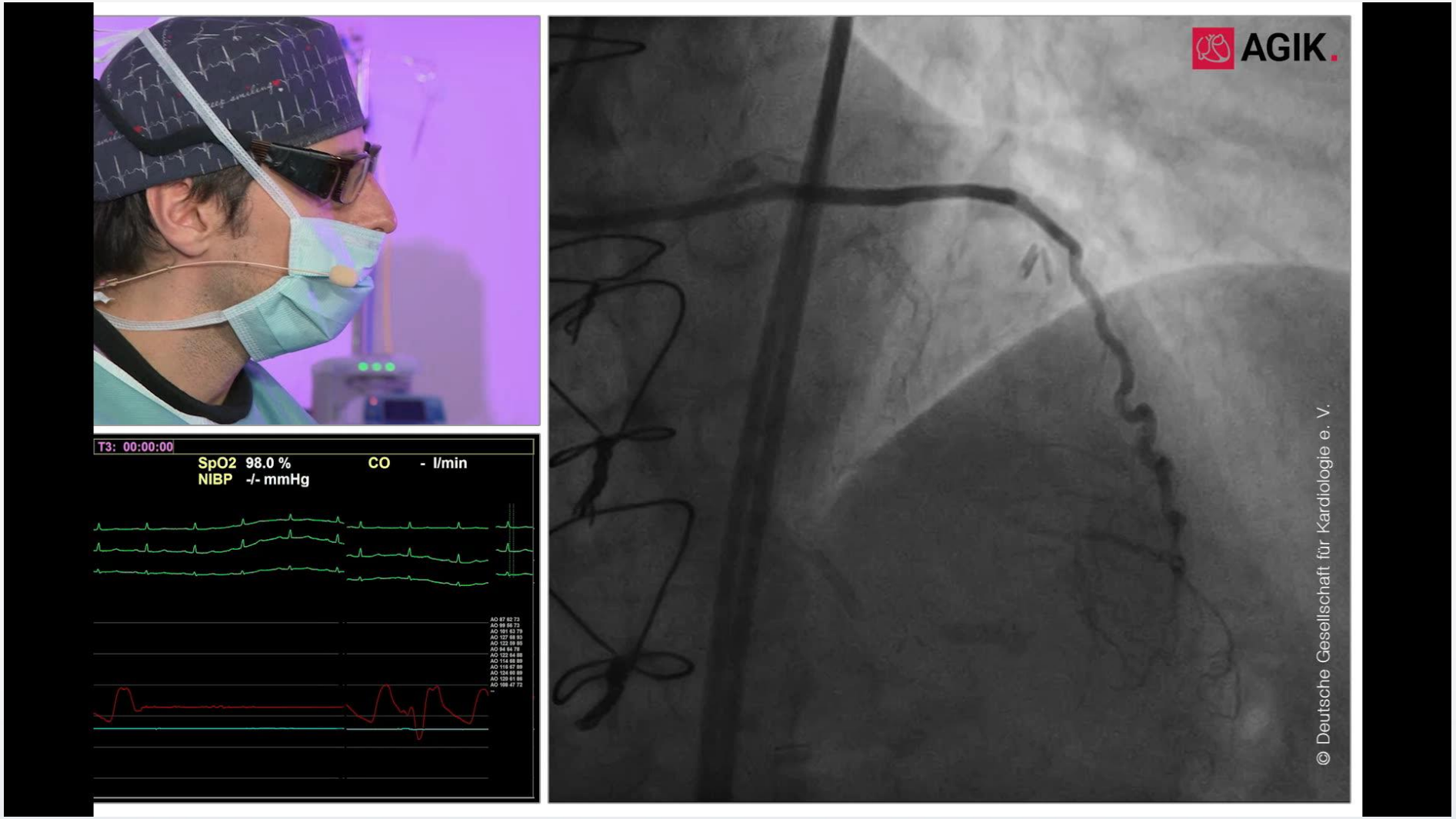


Tanaka K, et al. JACC Cardiovasc Interv. 2023 Jun 26;16(12):1546-1548.

Recent trends in Europe/US

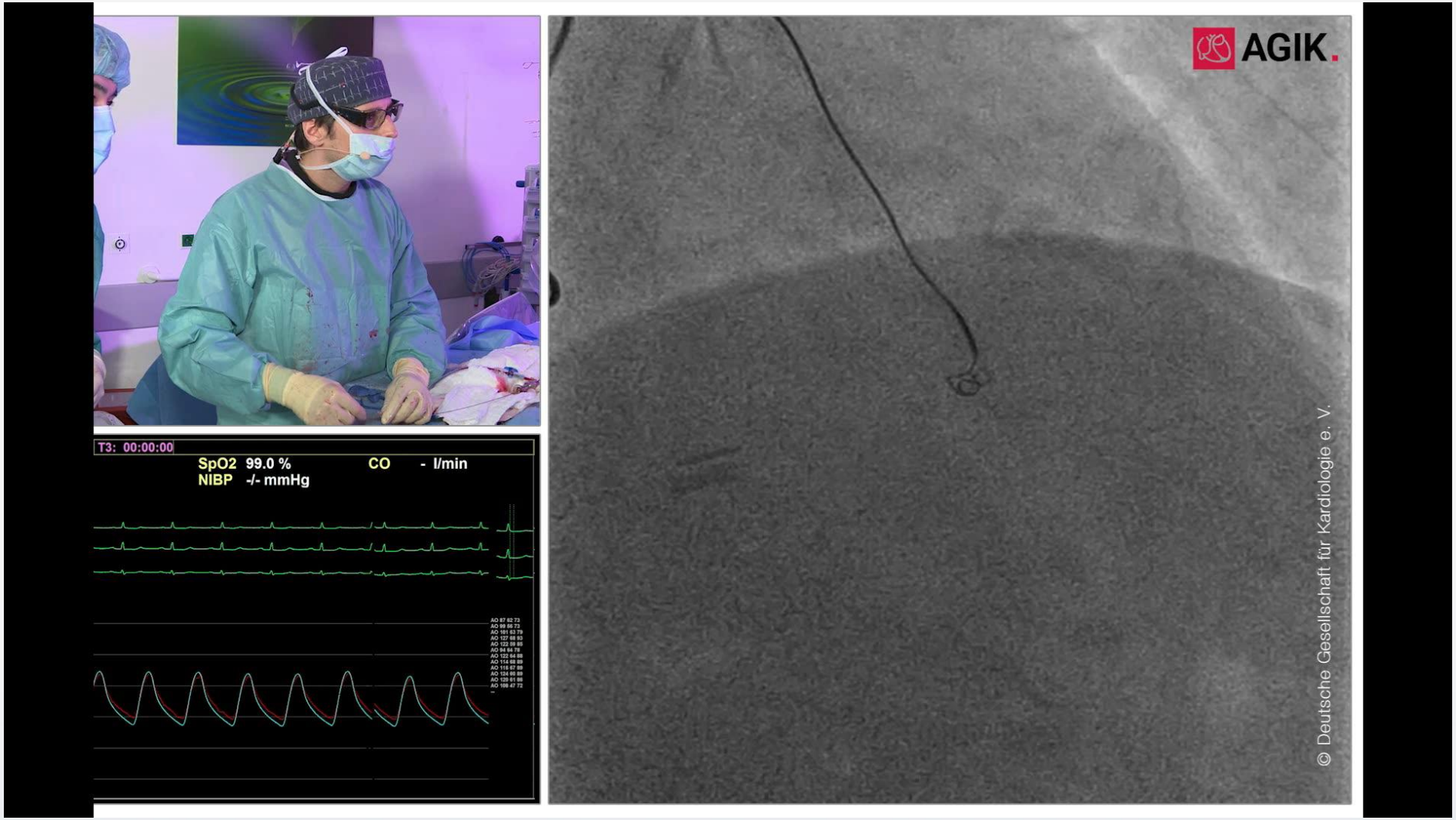
- **Further tendency toward safer and more efficient procedures**
  - ✓ Brief AWE attempt
  - ✓ Knuckling rather than conventional wiring especially for long CTO
  - ✓ STAR or Stingray-ADR rather than a risky or difficult retrograde
  - ✓ Investment procedure

STAR technique for no-option LAD/Dg CTOs



By courtesy of Dr. Kambis Mashayekhi

STAR technique for no-option LAD/Dg CTOs



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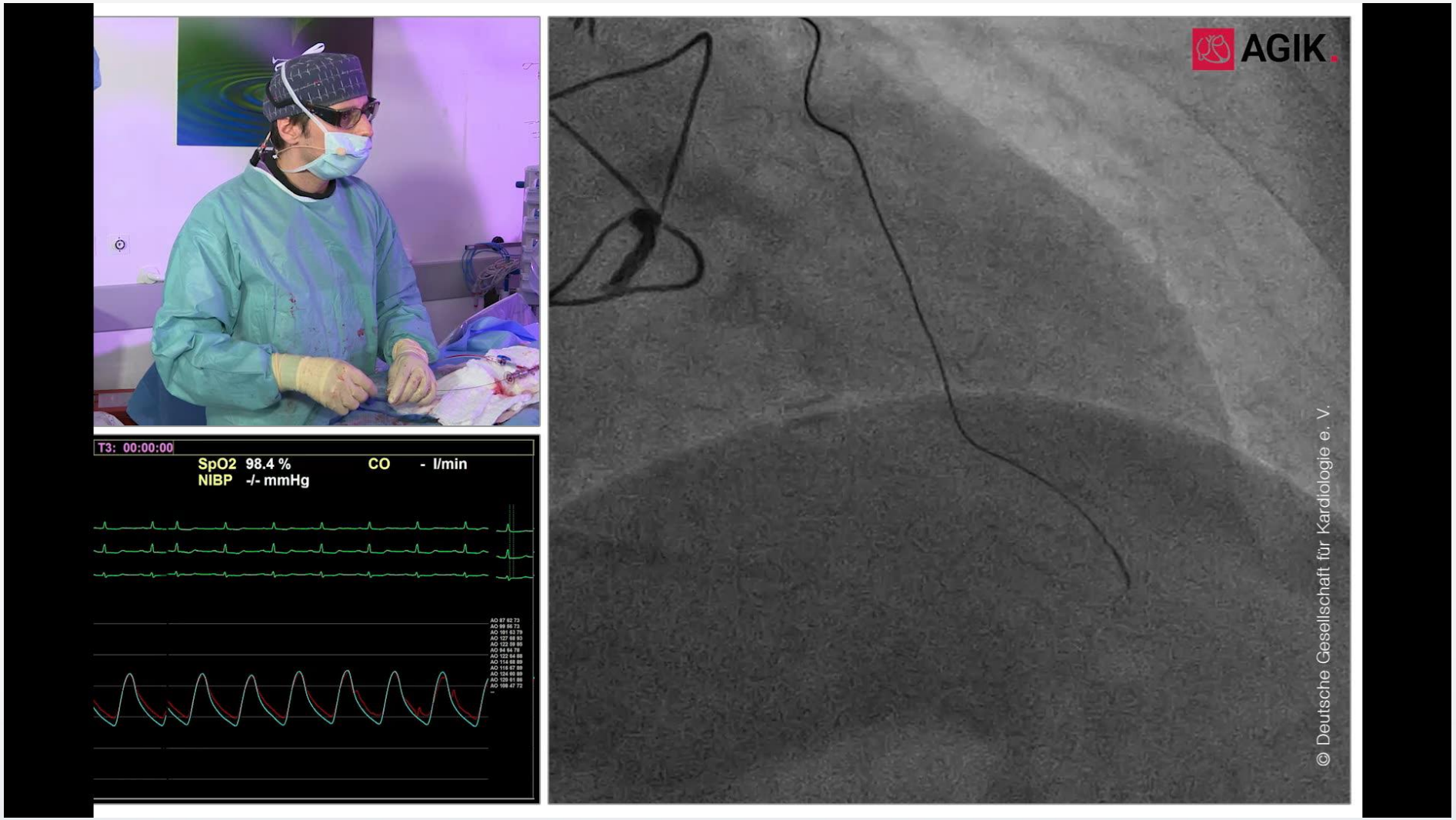

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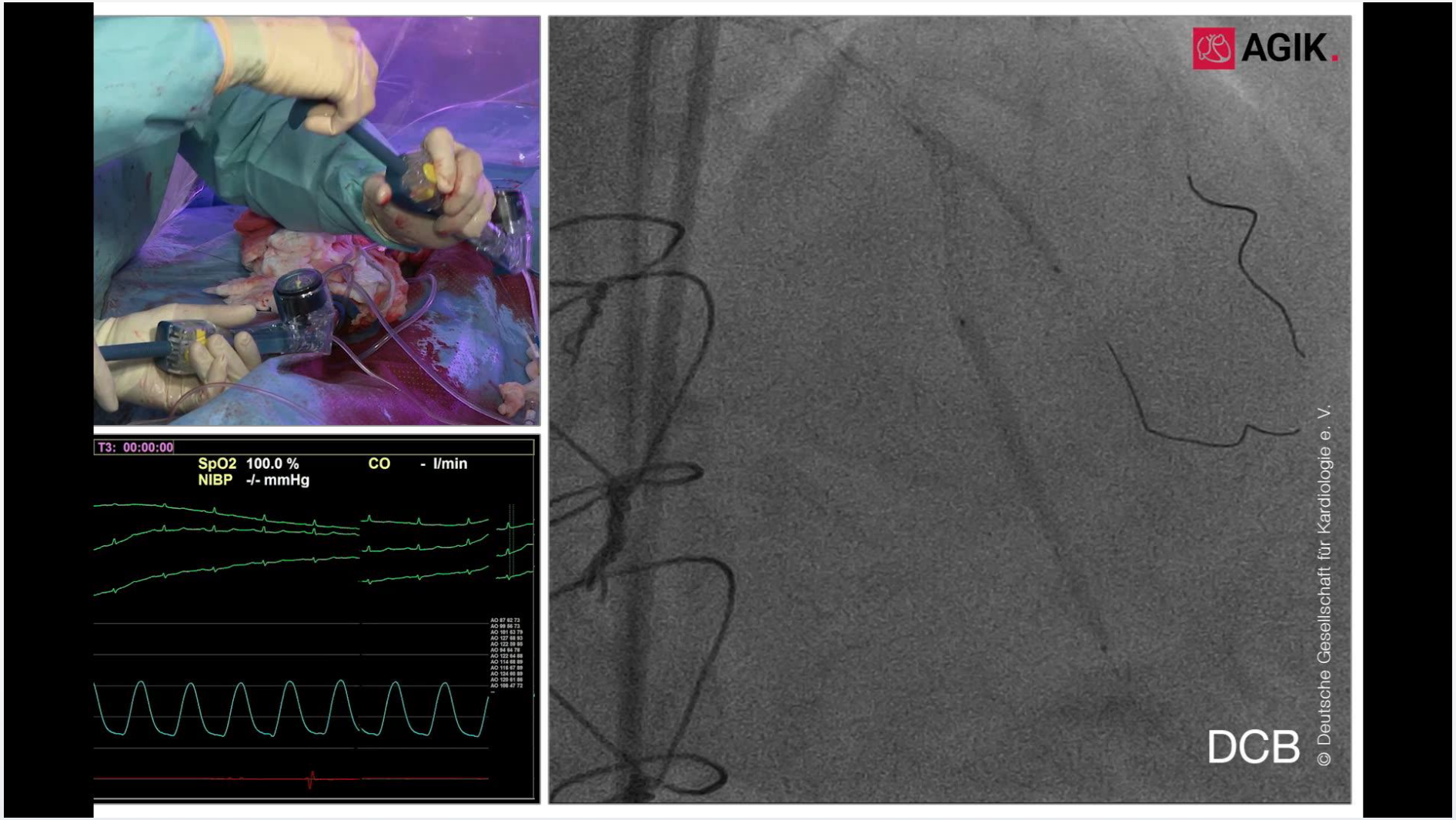

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Success rates of CTO PCI have become uniform

Regions	Author	Year	N (centers or operators)	N (CTO lesions)	J-CTO score	Technical success (%)	In-hospital MACCE (%)	Fluoroscopy time (min)	Procedure time (min)	Contrast volume (ml)
US	Michael et al.	2015	3 centers	1363	NA	85.5	1.8	42±29	113±61	294±158
	Sapontis et al.	2015	4 centers	380	2.9±1.1	91.3	2.6	39	109	240
	Christopoulos et al.	2016	7 centers	781	NA	92.9	NA	42	114	250
Europe	Galassi et al.	2011	16 centers	1983	NA	81.0	1.7	42±47	105±57	313±184
	Maeremans et al.	2016	17 centers	1253	2.2±1.3	86	2.6	35	90	250
Asia-Pacific	Morino et al.	2010	12 centers	528	NA	87.7	3.3	45	NA	293
	Habara et al	2016	18 centers (higher volume)	1782	1.6±1.1	90.6	0.45	63±43	138±84	236±108
			38 centers (lower volume)	1447	1.5±1.1	85.6	0.62	73±48	161±87	217±102
	Chan et al.	2019	8 operators	497	2.9±1.2	93.8	3.8	88	175	260
	Matsuno et al.	2022	45 operators (ER)	4316	1.9±1.1	90.1	1.7	-	157±89	222±102
			46 centers (RSGR)	2230	2.2＋1.2	88.9	1.5	-	159±90	206±98

There is no evidence that Japanese CTO PCI is superior to others!

Japanese operators should be open-minded

- Continue to improve our strengths
- Throw out excess obsession and avoid sacrificing efficiency
- Understand and respect different ways of thinking and doing CTO PCI
- Learn unfamiliar skills and techniques and utilize them in complex cases with limited options

Conclusions

- CTO PCI can vary among countries and regions due to the differences in patient/ lesion characteristics, operators' skillset/ mindset, available equipment, and surrounding environment.
- To further improve ourselves, we Japanese operators need to know and accept different concepts and techniques of CTO PCI.