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Outcomes with IVL Treatment of Calcified CAD

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Disclosure

- Honorarium and educational activities (CME) support (*in the last 12 months, in alphabetical order*) – Abbott Vascular, Astra Zeneca, Boston Scientific, Medtronic, Novartis, Terumo

Calcified CAD

The Problem…

- Prevalence of calcified coronary lesions set to increase with ↑ prevalence of factors such as hypertension, ageing and diabetes.
- Calcified lesions lead to sub-optimal PCI and clinical outcomes:
  - limiting lesion crossing,
  - altering drug elution kinetics,
  - interfering with optimal stent expansion,
- Rotational or orbital atherectomy, are associated with:
  - increased periprocedural complications
  - without clear clinical evidence of efficacy
- There is thus an unmet need for effective and safe methods to prepare calcified lesions and improve PCI outcomes

How to treat calcified CAD

What are the 'traditional' tools?

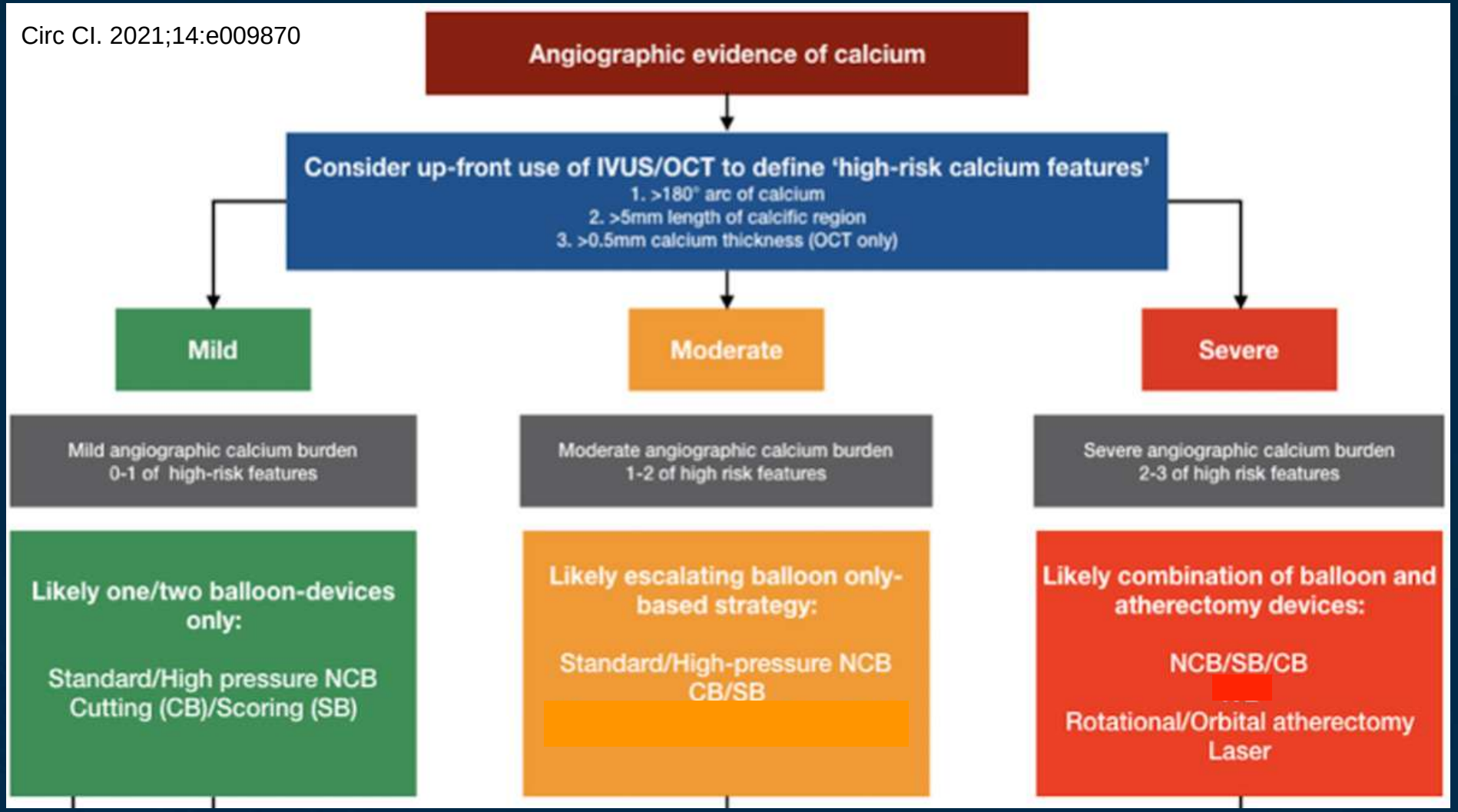
- Semi compliant balloon
- Non-compliant balloon
- Scoring/cutting balloon?
- Ultra high pressure non compliant balloon (OPN)?
- Rotational atherectomy?
- Orbital atherectomy?
- Laser??

- What is the sequence???

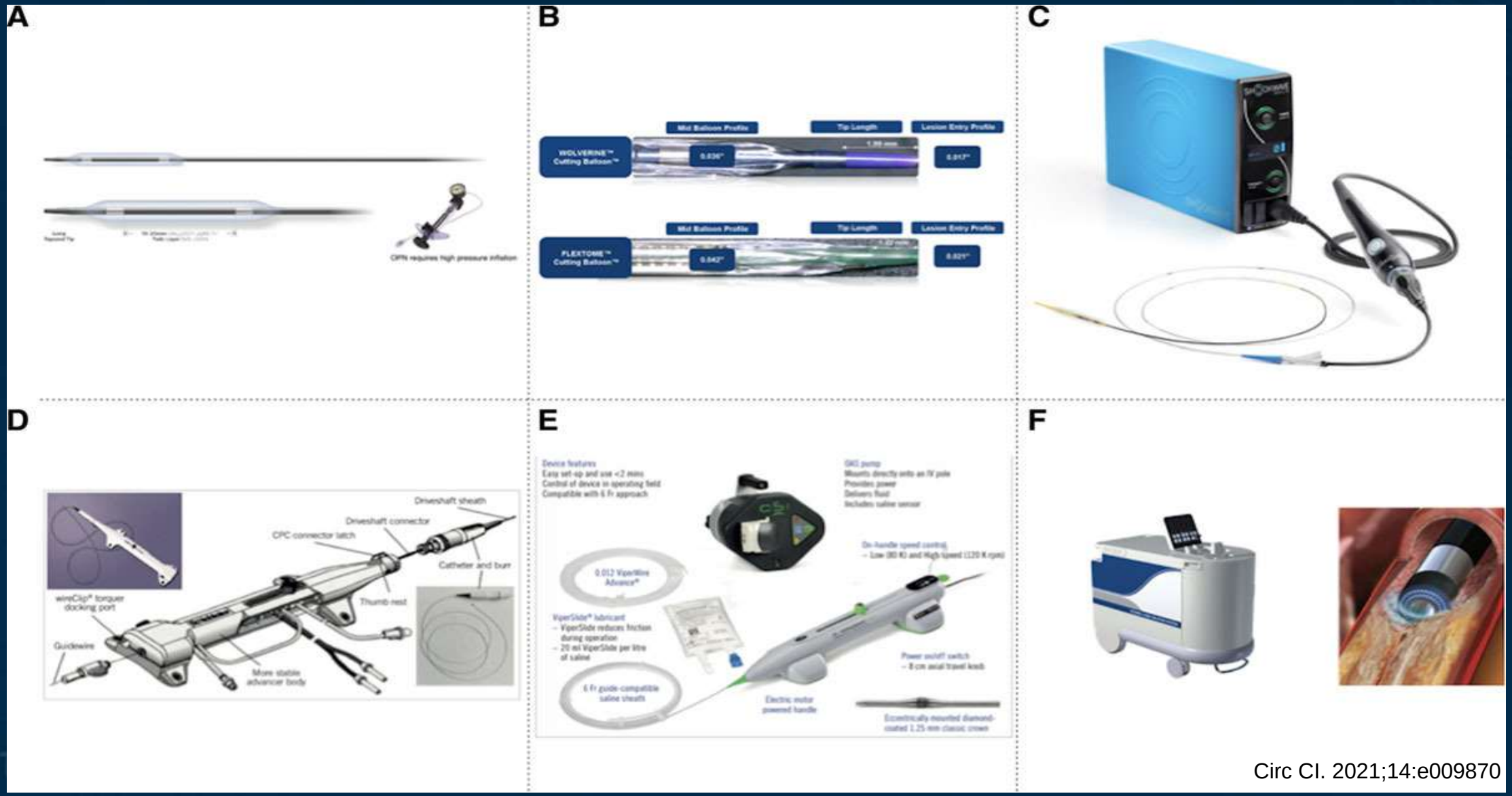
Recent paradigm

How to treat calcified CAD…?

Circ CI. 2021;14:e009870



When to use what?

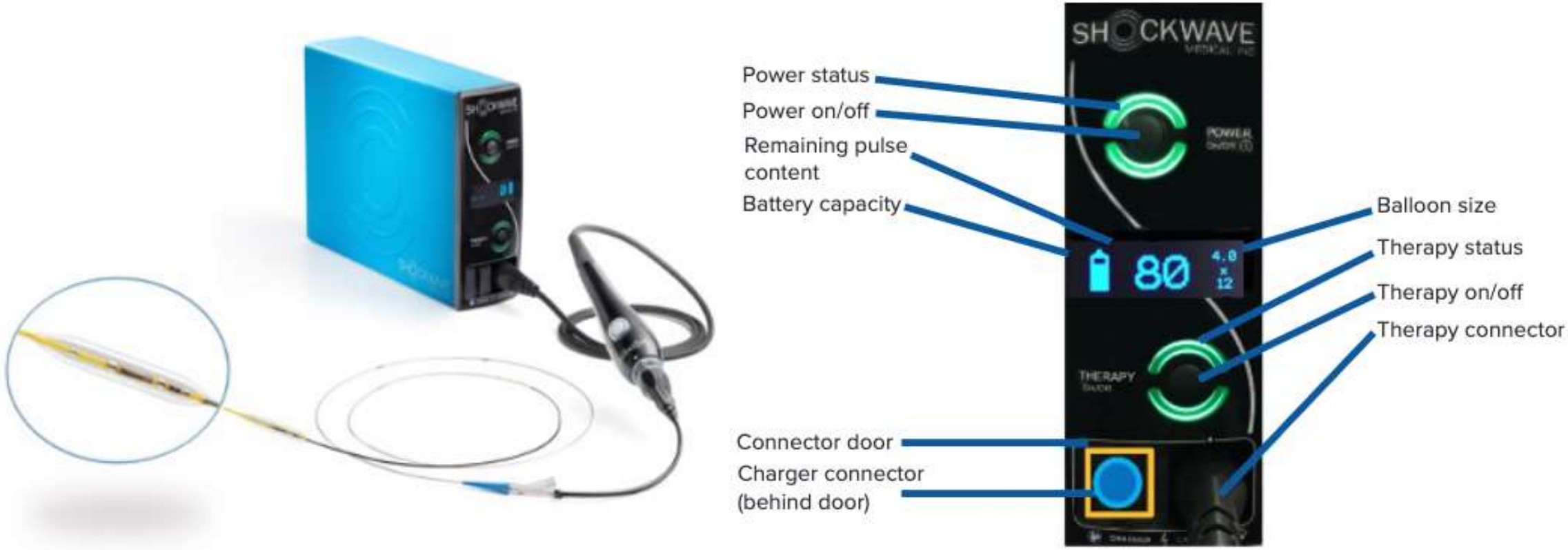


Circ CI. 2021;14:e009870

Comparison of technologies

MY OPINION!

	'safety'	Efficacy	Ease of use	Uncrossables
SC balloon	+++	±	+++	NA
NC balloon	++	+	++	NA
OPN balloon	+±	++	+±	NA
Scoring balloon	++	+	++	NA
Cutting balloon	++	+	++	NA
Rotational atherectomy	-	+++	±	+++
Orbital atherectomy	-	++	±	+
Laser	?	?	?	?



The system is composed of a generator – a connector and the C2 catheter. The generator has two buttons: the upper button switches on the generator and the lower button allows the delivering of the therapy by the generator. Note that for security reasons, you cannot plug the generator to the general electric alimentation through the charge connector when the connector is plugged to the therapy connector. The connector is related to the catheter through a magnetic plug and supports the therapy button. Reproduced with permission from Shockwave Medical.

I V L

Pros and Cons… simplified!

PROS

- Safe
- Simple
- Easy to setup
- Bifurcations
- Can disrupt calcium

CONS

- Bulky
- Bursts
- Cost
- ?place in the algorithm

DISRUPT CAD series

Clinical evidence for I V L

- DISRUPT CAD-I (n=60) Single-arm, pre-market study demonstrating the safety and performance of IVL in heavily calcified, coronary lesions prior to stenting and followed to 6 months; also included an OCT Sub-study demonstrating IVL's mechanism of action.
- DISRUPT CAD-II (n=120) EU Post-Market Study - In-hospital MACE 5.8%
- DISRUPT CAD-III (n=384) US study for FDA approval
- DISRUPT CAD-IV (n=64) Japanese study. 30d MACE 6.3%, 1yr MACE 9.4%

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DISRUPT CAD III

Prospective, multicenter, single-arm global IDE
NCT03595176

Heavily calcified†, *de novo* coronary lesions
RVD 2.5-4.0 mm, stenosis ≥50%, lesion length ≤40mm
One roll-in patient per site allowed
47 global sites

Roll-in Population
N = 47

ITT Population
N= 384

30-day Follow-up

1-year Follow-up

2-year Follow-up

OCT Sub-study
N= 100

Richard Shlofmitz, MD
TCT 2020

*Kereiakes et al., *Am Heart J* 2020;225:10-18.
†Radio-opacities both sides of vessel ≥15 mm length by angiography or calcium angle ≥270° by OCT or IVUS

Angiographic Complications

DISRUPT CAD III

Core Lab Analysis	Immediately Post-IVL	Final Post-stent
Any serious angiographic complication	2.6%	0.5%
Severe dissection (Type D-F)	2.1%	0.3%
Perforation	0.0%	0.3%
Abrupt closure	0.0%	0.3%
Slow flow	0.6%	0.0%
No-reflow	0.0%	0.0%

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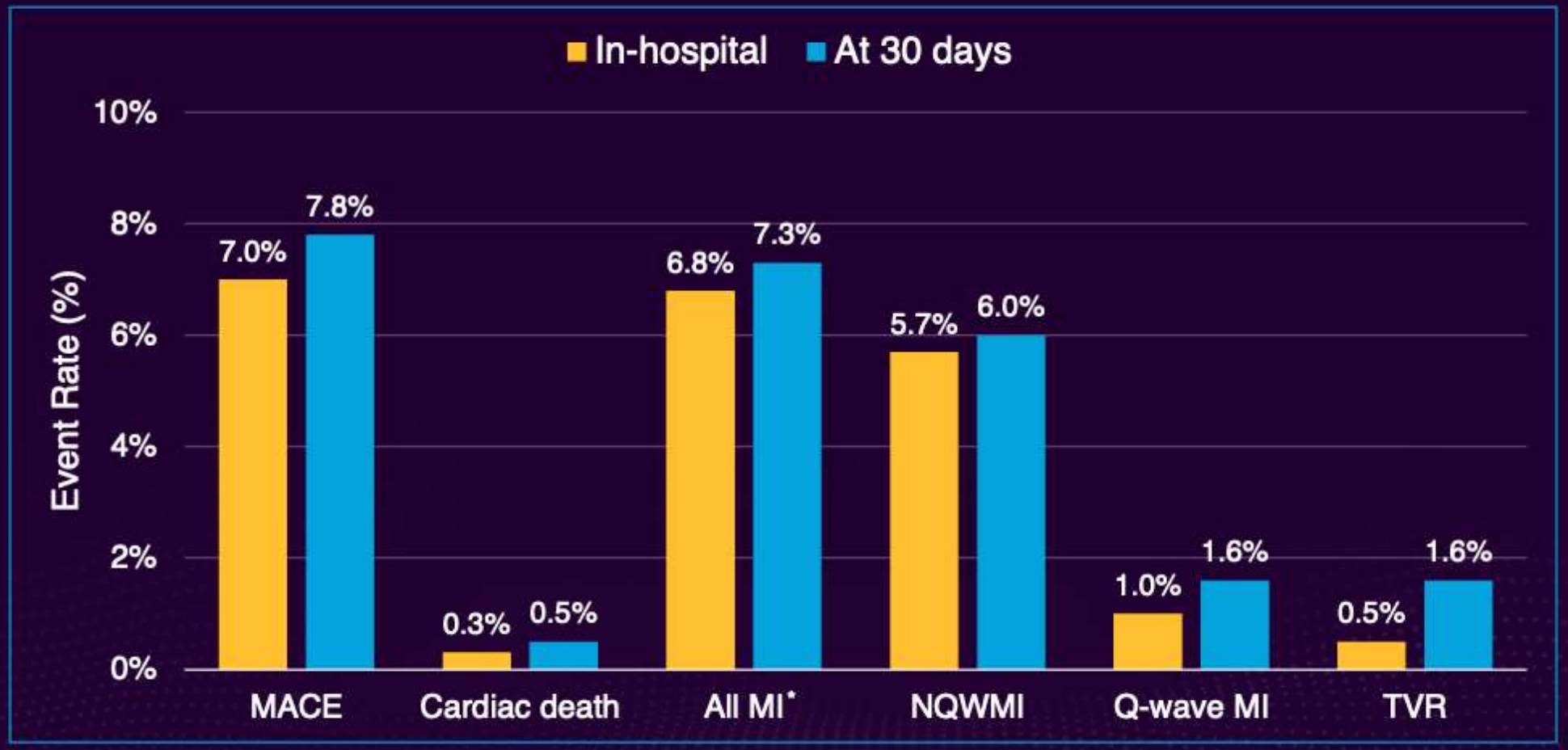
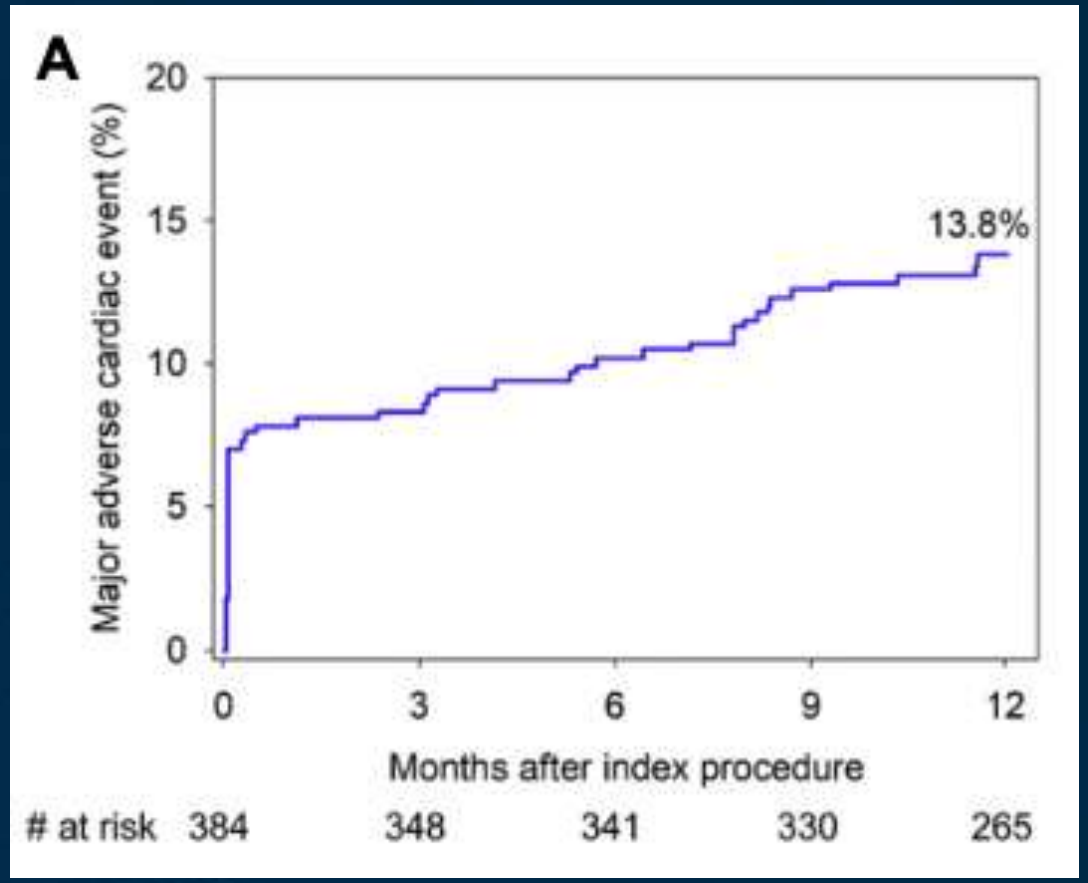
In-hospital and 30-day MACE

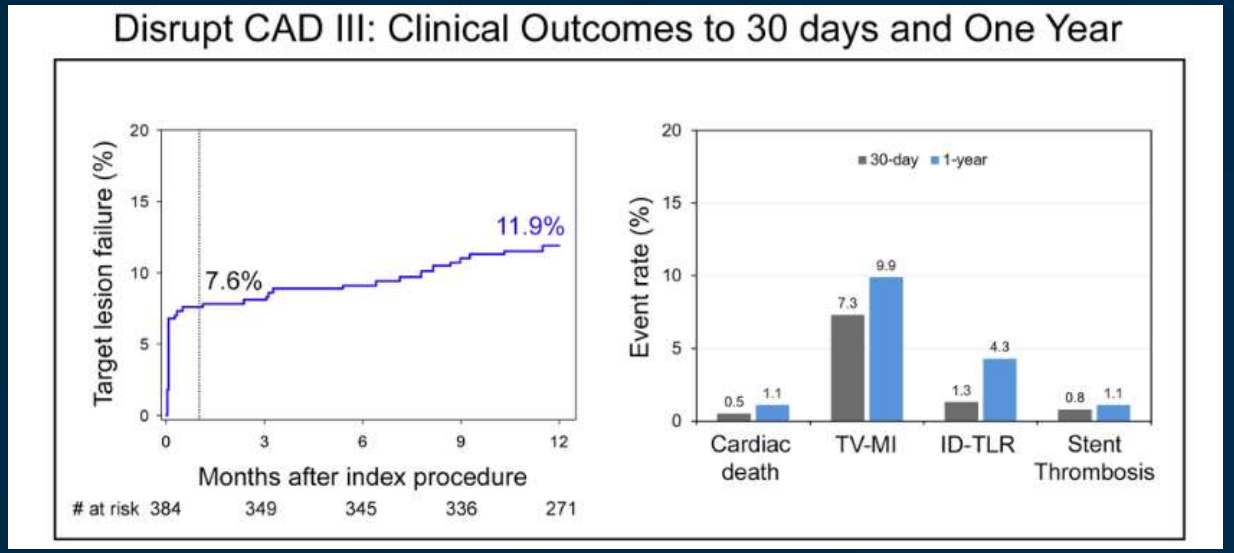
DISRUPT CAD III



*Per protocol: CK-MB level >3x ULN at discharge (peri-procedural MI) and using the 4th Universal Definition of MI beyond discharge

DISRUPT CAD-III 1 year





J Am Coll Cardiol 2020 Dec 1;76(22):2635-2646

Brief History of IVL @ NHCS

- 2017 : started use
- Oct 2019 : DISRUPT CAD II
- Jan 2020 : MOHH grants permission for IVL under constrained use framework
- NHCS IVL registry established
- Oct 2020 : DISRUPT CAD III
- Jan 2021 : MOHH full approval for IVL use

Initial NHCS experience

- Fifty-three patients who received IVL from January 2017 to July 2020 were retrospectively compared to 271 patients who received RA from January 2017 to December 2018.
- Median age 72 vs 70
- ACS 57% vs 25%
- Emergency PCI 17% vs 2.2%
- LM 30.2% vs 25.8%, TVD 75% vs 73%

Korean Circ J. 2022 Apr; 52(4): 288–300

Table 3

In-hospital and 30-day outcomes

Variables	In-hospital outcomes			30-day outcomes		
	IVL (n=53)	RA (n=271)	p value	IVL (n=53)	RA (n=271)	p value
MACE*	6 (11.3)	16 (5.9)	0.152	9 (17.0)	20 (7.4)	0.035
MI	4 (7.5)	9 (3.3)	0.152	5 (9.4)	11 (4.1)	0.154
TVR	0 (0.0)	0 (0.0)	NA	0 (0.0)	0 (0.0)	NA
All-cause Mortality	3 (5.7)	8 (3.0)	0.319	3 (5.7)	10 (3.7)	0.453
Stent Thrombosis	0 (0.0)	0 (0.0)	NA	1 (1.9)	0 (0.0)	0.024
Stroke	0 (0.0)	0 (0.0)	NA	2 (3.8)	0 (0.0)	0.001

Open in a separate window

Values are presented as median (interquartile range) or number (%).

IVL = intravascular lithotripsy; MACE = major adverse cardiovascular events; MI = myocardial infarction; NA = not available; RA = rotational atherectomy; TVR = target vessel revascularization.

*MACE is the composite of MI, all-cause mortality, target vessel revascularization TVR, and stroke.

Korean Circ J. 2022 Apr; 52(4): 288–300

Initial NHCS IVL Registry data

Aug to Dec 2019

- n = 50 lesions (45 patients).
- Procedural success 94%, Clinical success 90%.
- In-hospital MACE 6% , 30-day MACE 8%

J Invasive Cardiol. 2021 Jun;33(6):E417-E424

NHCS IVL Registry

Aug 2019 – Apr 2022

- n = 174
- Significant CKD cohort
  - eGFR < 60 mL/ min/ 1.73 m2
    - **N = 65/174 (37.4%)**
  - Renal replacement therapy
    - N = 27/174 (15.5%)
- DM 68%
- ACS 42%
- TVD 74%, LM 22%
- IVUS 35%, OCT 9%

Manuscript being submitted

Clinical Outcomes

All Comers			
	In-hospital	**30-days**	**1-year**
	(n = 174)	**(n = 174)**	**(n = 73**)**
MACE*	15(8.6%)	19(10.9%)	16(21.9%)
MI	6(3.4%)	7(4.0%)	6(8.2%)
TVR	0(0.0%)	1(0.6%)	5(6.8%)
All-cause Mortality	5(2.9%)	7(4.0%)	8(11.0%)
Stent Thrombosis	0(0.0%)	1(0.6%)	1(1.4%)
Stroke/TIA	6(3.4%)	8(4.6%)	3(4.1%)
Perforation	3(1.7%)		
Slow/No reflow	2(1.1%)		

Continuous variables are reported as median(IQR) and categorical variables as n(%)
*MACE is defined as the composite endpoint of MI, All-cause mortality, TVR and stroke
** For cases who had their IVL procedures in Year 2019-2020
MI indicates myocardial infarction; TVR target vessel revascularization; TIA, transient ischemic attack; IVL, intravascular lithotripsy.

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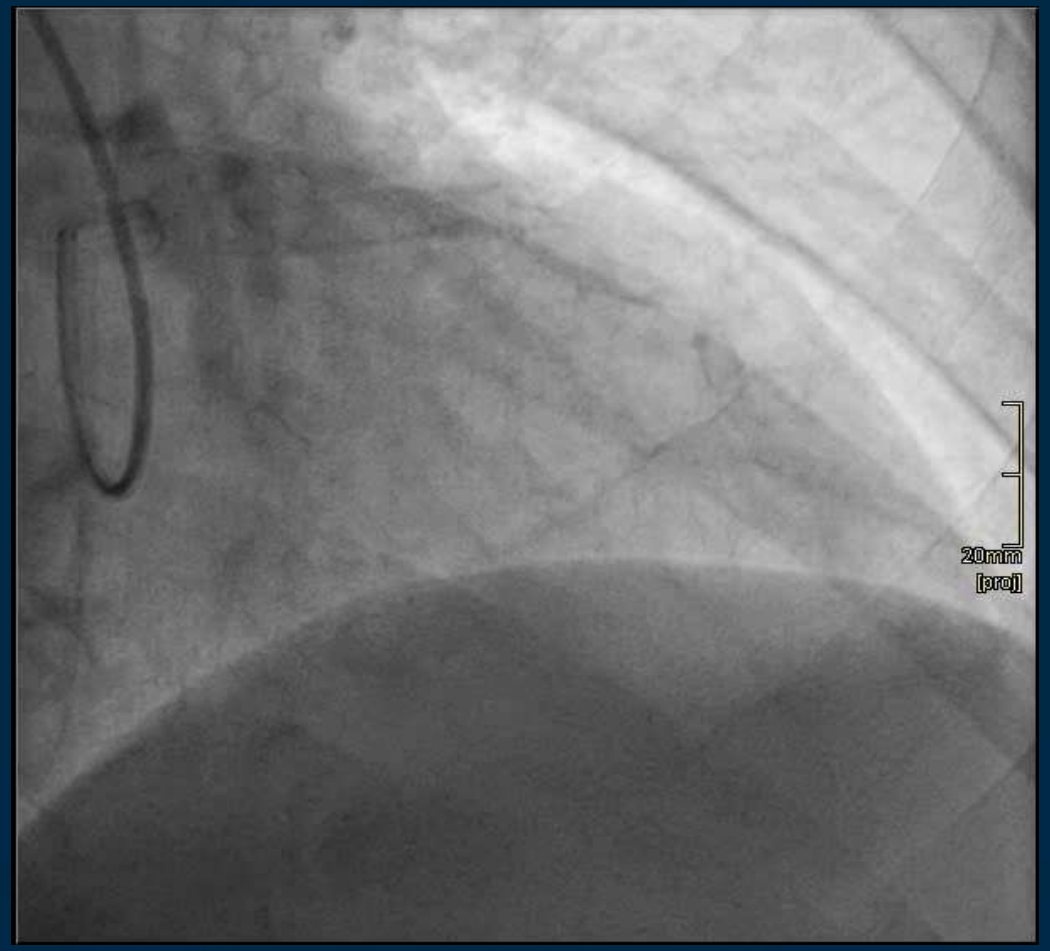
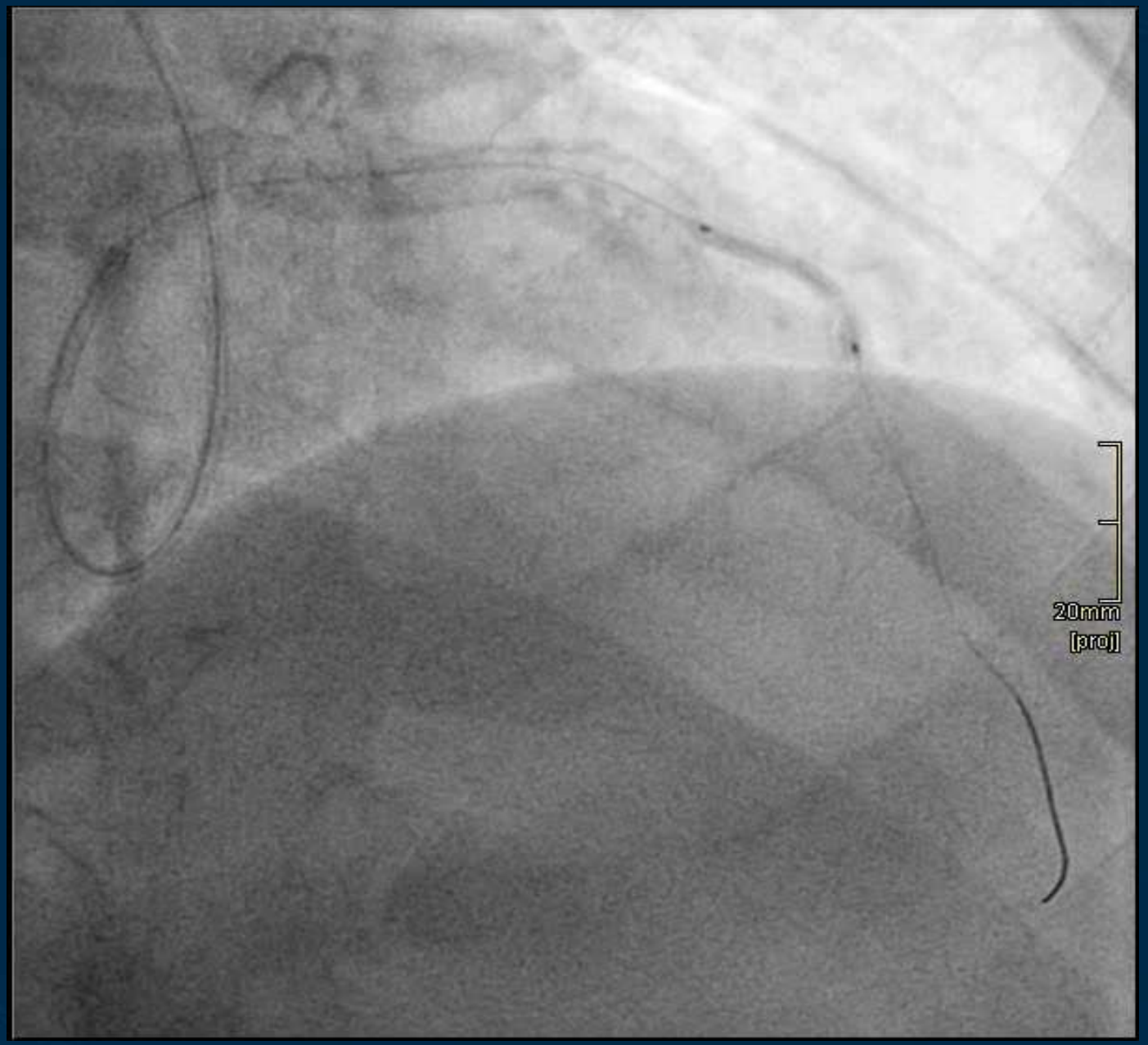
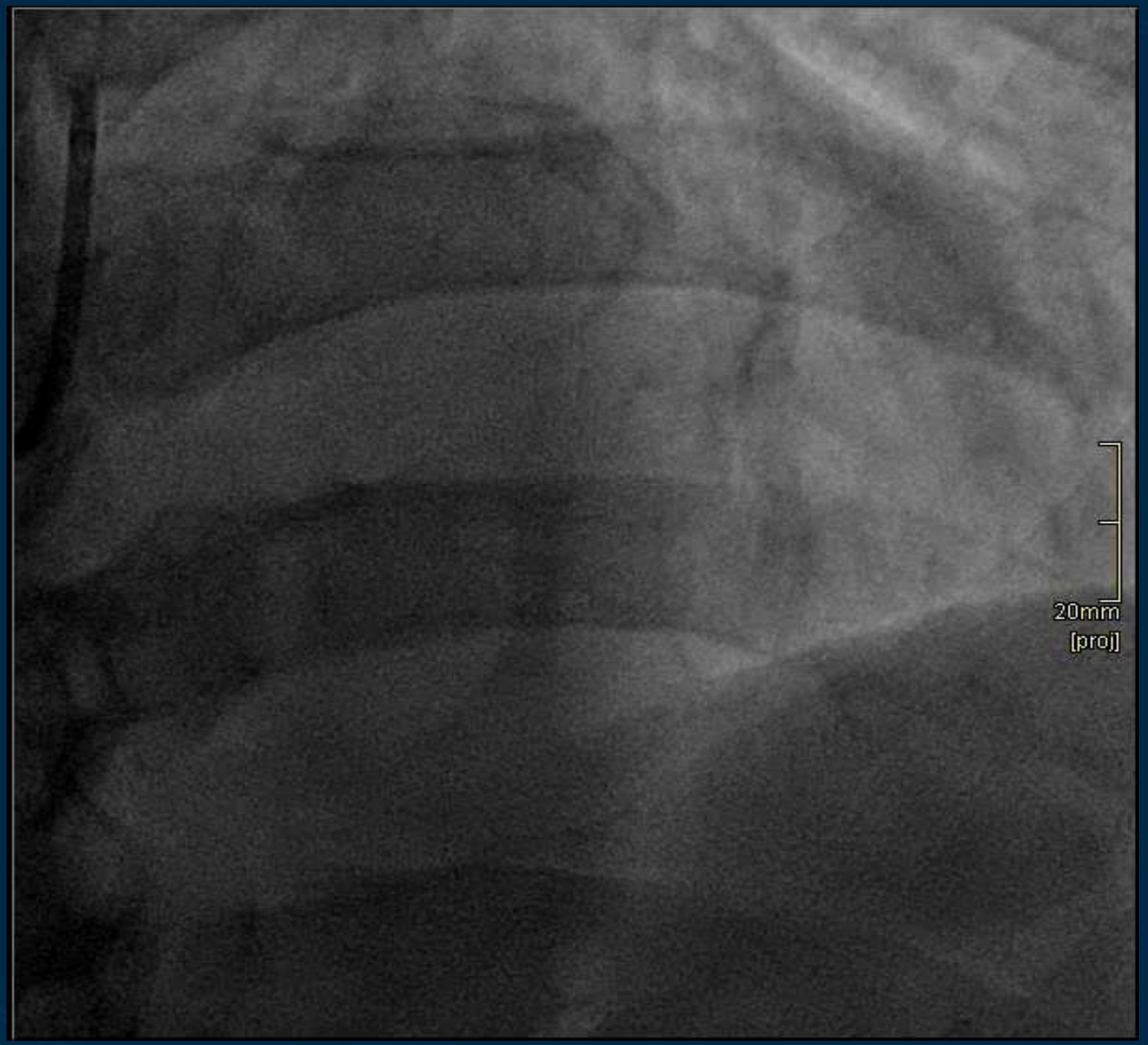
Case study







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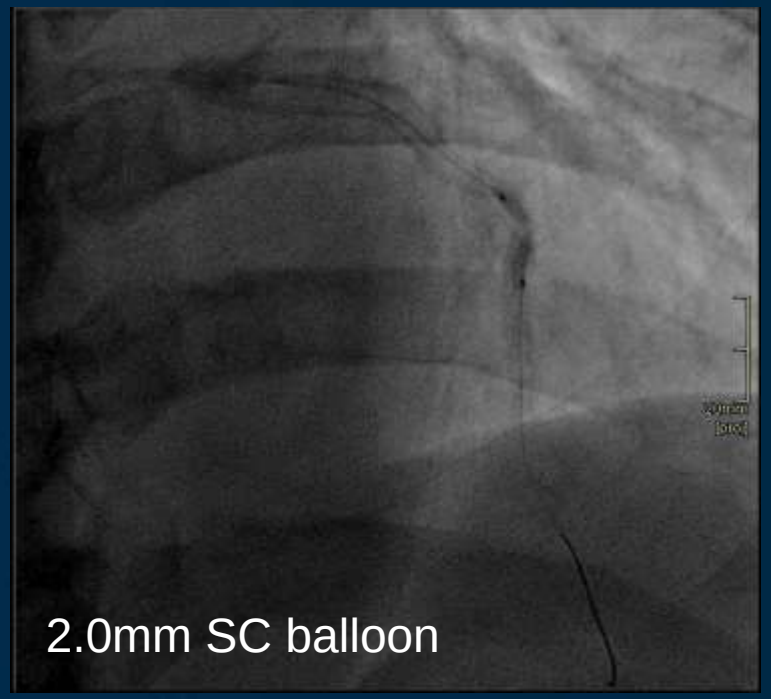
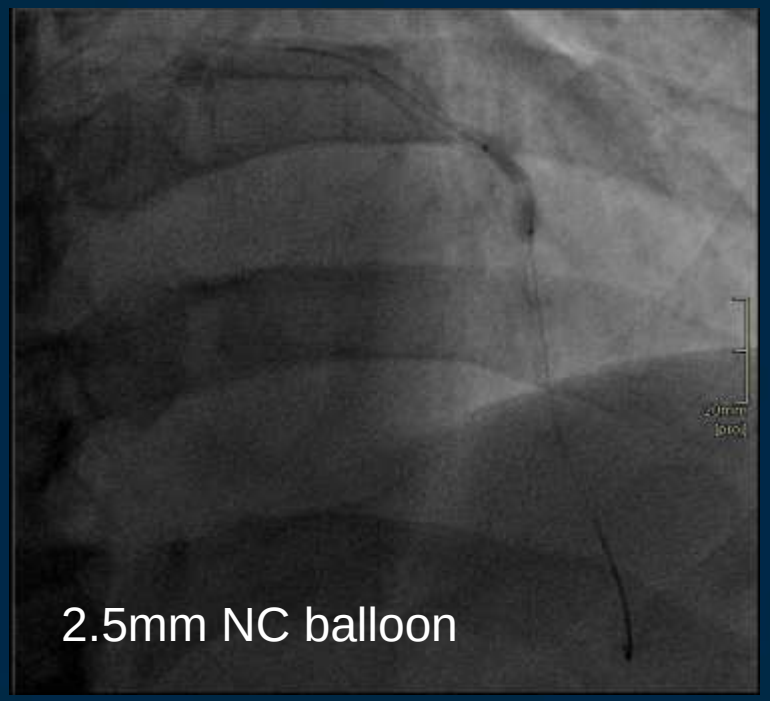
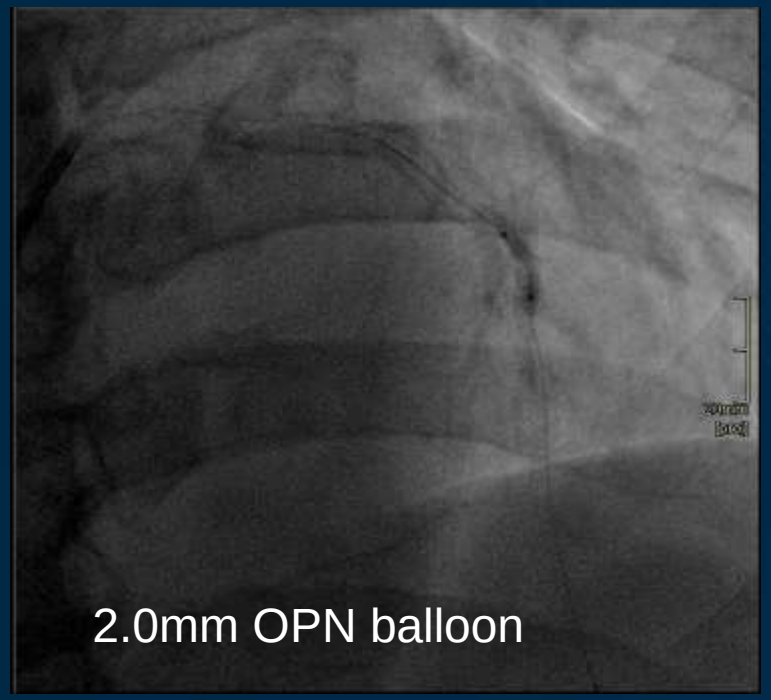
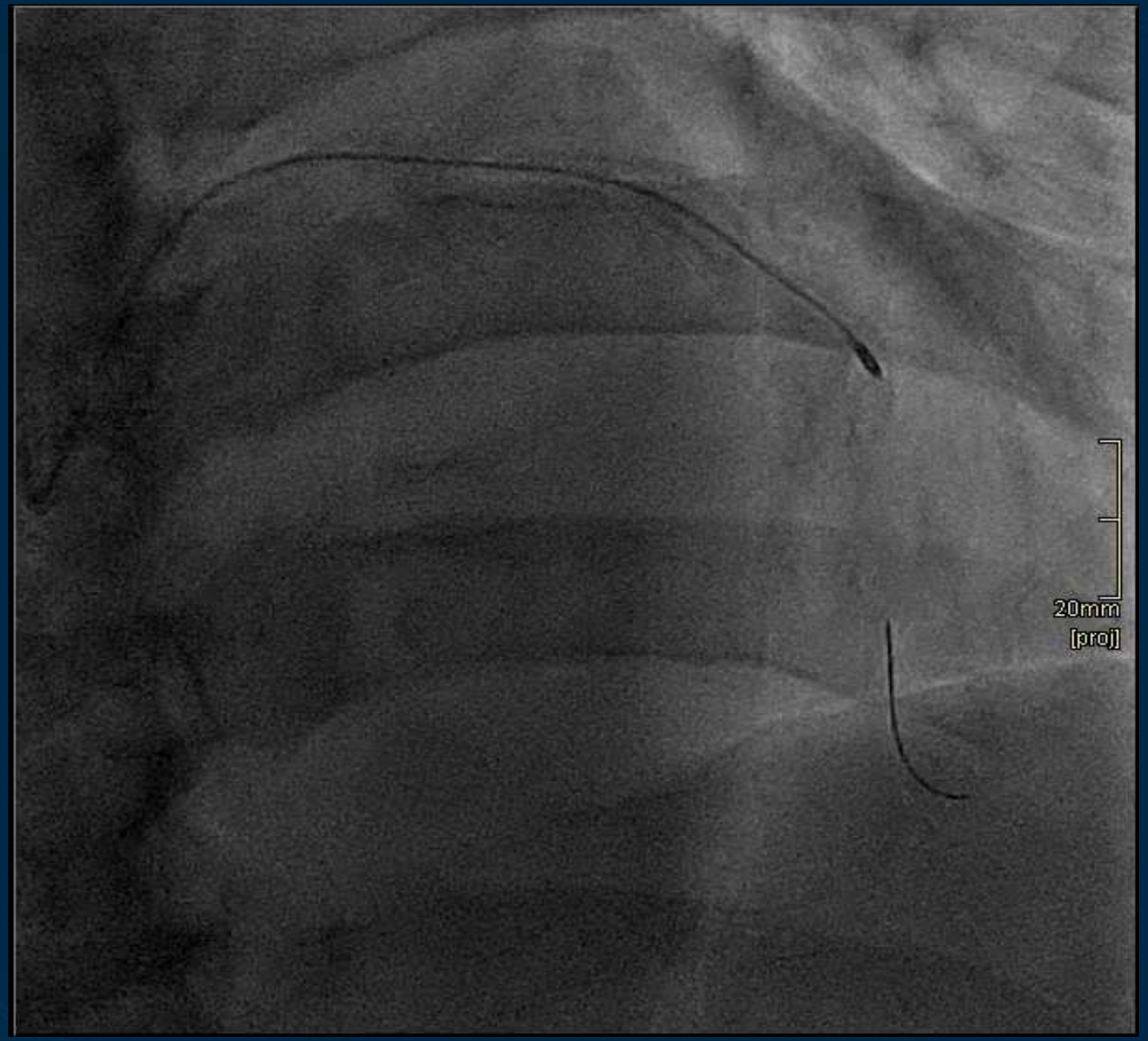
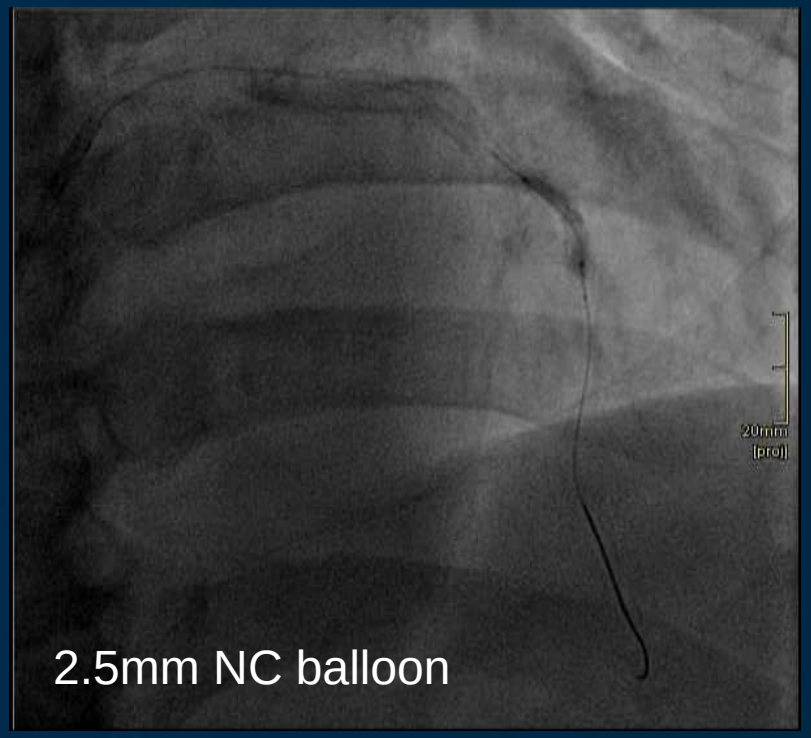

2.0mm SC balloon

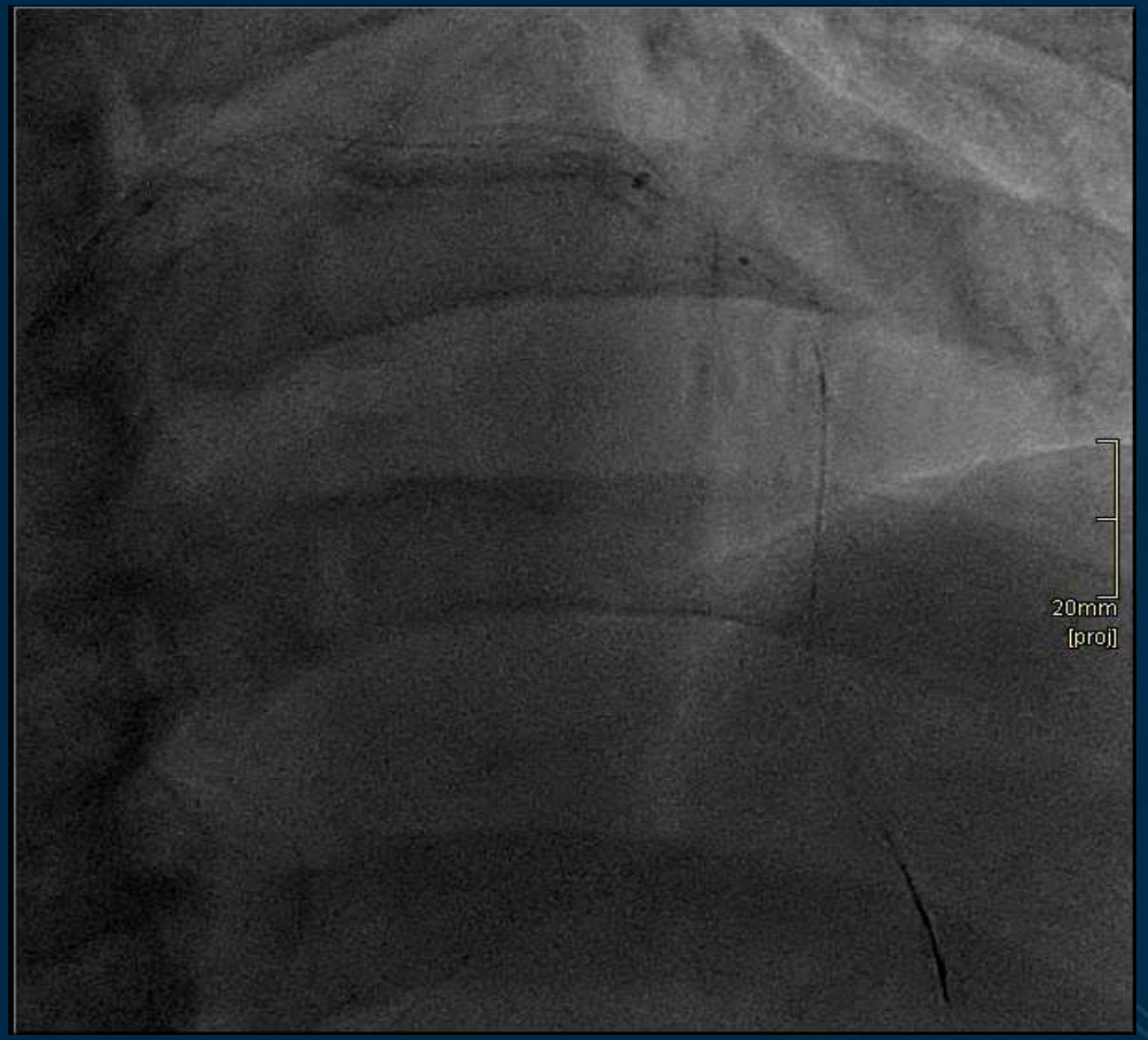

2.5mm NC balloon


2.0mm OPN balloon





2.5mm NC balloon



IVL

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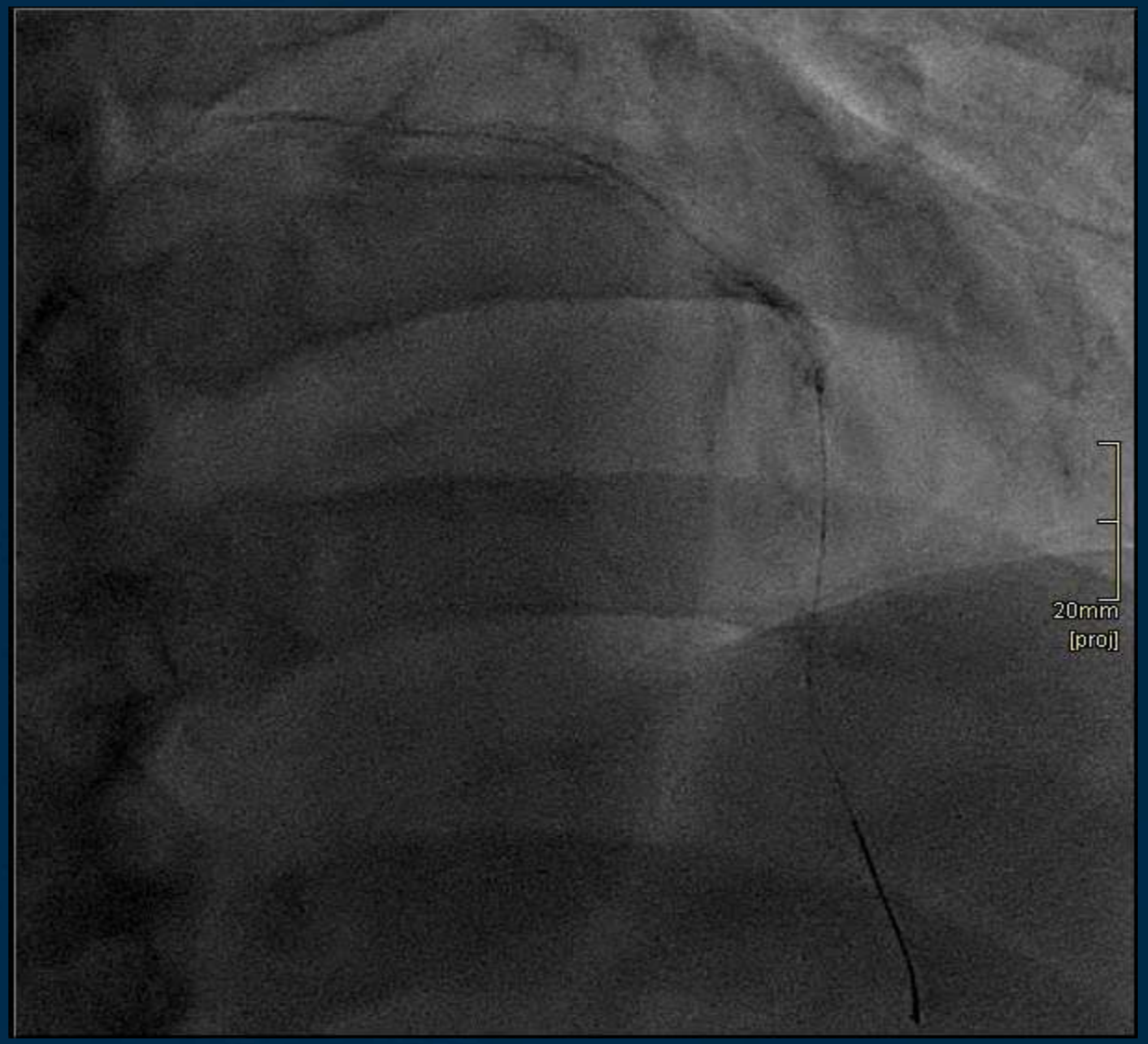
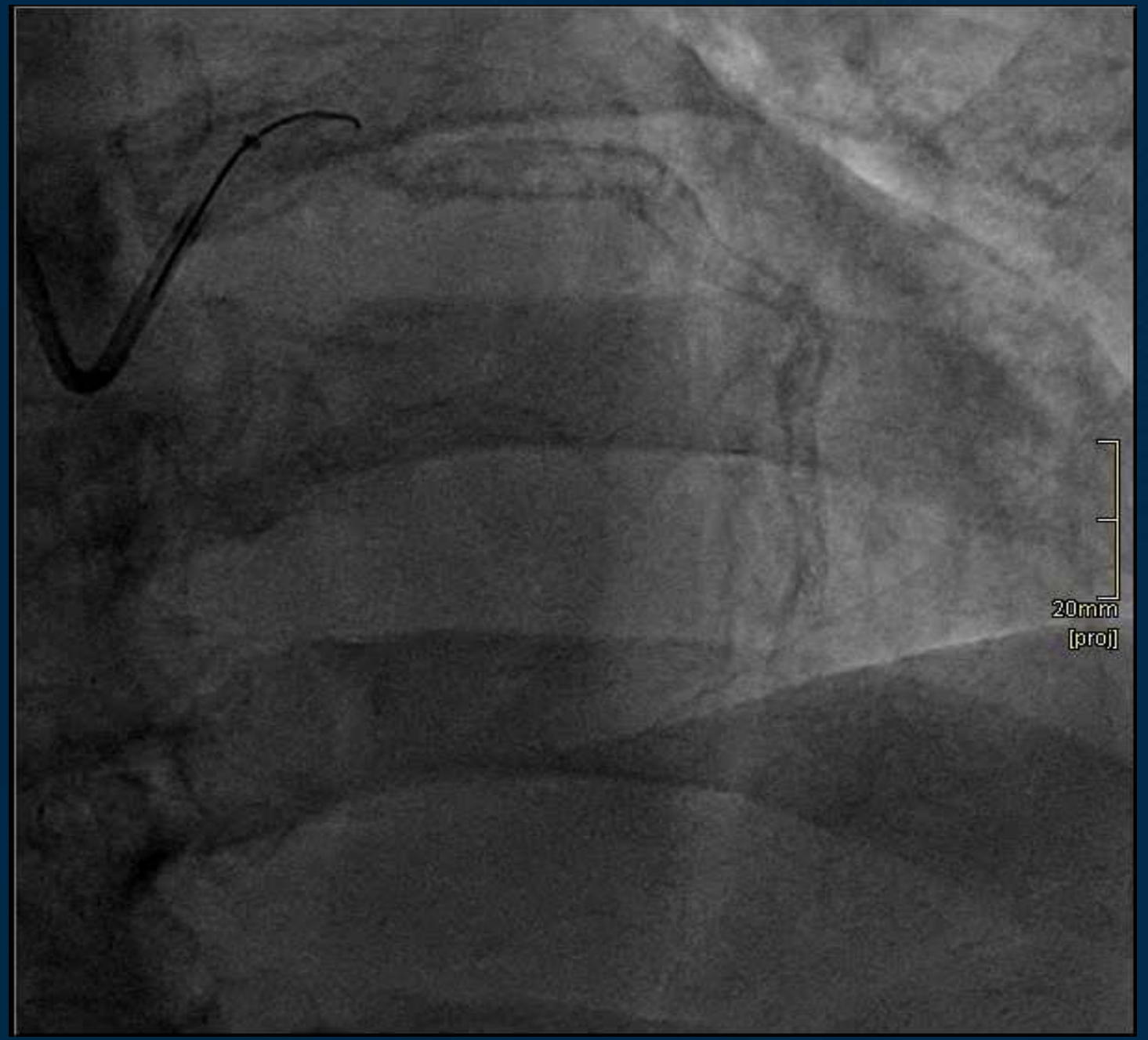



20mm
[proj]


20mm
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Rotatripsy

ACS 40%, TVD 75%, ISR 25%

In-hospital outcomes

	NHCS	Buono et al (RA+IVL)	Rola et al (RA+IVL)	DISRUPT CAD III (IVL only)	ROTAXUS (RA only)	PREPARE-CALC (RA only)
Total N	N=57	N=34	N=15	N=431	N=120	N=100
MACE *	8 (14%)	N.A.	6.7%	7%	4.2%	N.A.
MI	5 (8.8%)	N.A.	6.7%	6.8%	1.7%	1%
TVR	0 (0%)	0%	6.7%	0.5%	0.8%	0%
Mortality	3 (5.3%)	0%	0%	0.3%	1.7%	0%
Stent thrombosis	0 (0%)	N.A.	6.7%	N.A.	0%	0%
Stroke	3 (5.3%)	N.A.	0%	N.A.	N.A.	N.A.
Perforation	0 (0%)	8.8%	N.A.	0.3%	1.7%	2%
Cardiac death	N.A.	N.A.	N.A.	0.3%	N.A.	0%
Slow/No-reflow	6 (11%)	N.A.	N.A.	0%	0%	0%

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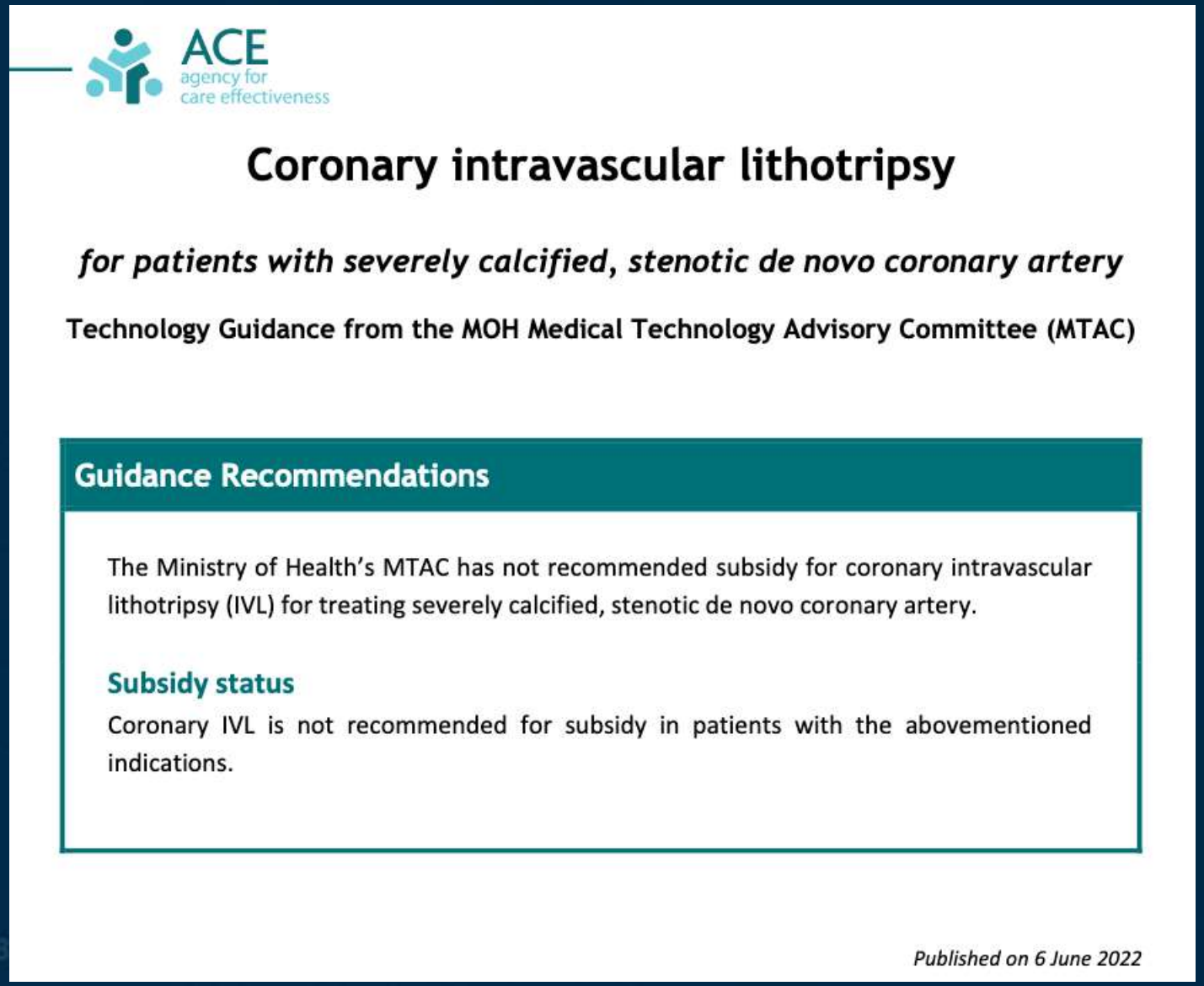
Rotatripsy

30 day outcomes

	N H C S	Rola et al (RA+IVL)	Dwivedi (RA+IVL)	DISRUPT-CAD III (IVL Only)
Total	N=57	N=15	N=21	N=383
MACE *	9 (16%)	6.7%	N.A.	7.8%
MI	5 (8.8%)	6.7%	4.8%	7.35
TVR	1 (1.8%)	6.7%	N.A.	1.6%
Mortality	4 (7.0%)	0%	4.8%	0.5%
Stent thrombosis	0 (0%)	N.A.	N.A.	0.8%
Stroke	3 (5.3%)	0%	0%	0%

Manuscript being submitted

Singapore situation



ACE
agency for
care effectiveness

Coronary intravascular lithotripsy

for patients with severely calcified, stenotic de novo coronary artery

Technology Guidance from the MOH Medical Technology Advisory Committee (MTAC)

Guidance Recommendations

The Ministry of Health's MTAC has not recommended subsidy for coronary intravascular lithotripsy (IVL) for treating severely calcified, stenotic de novo coronary artery.

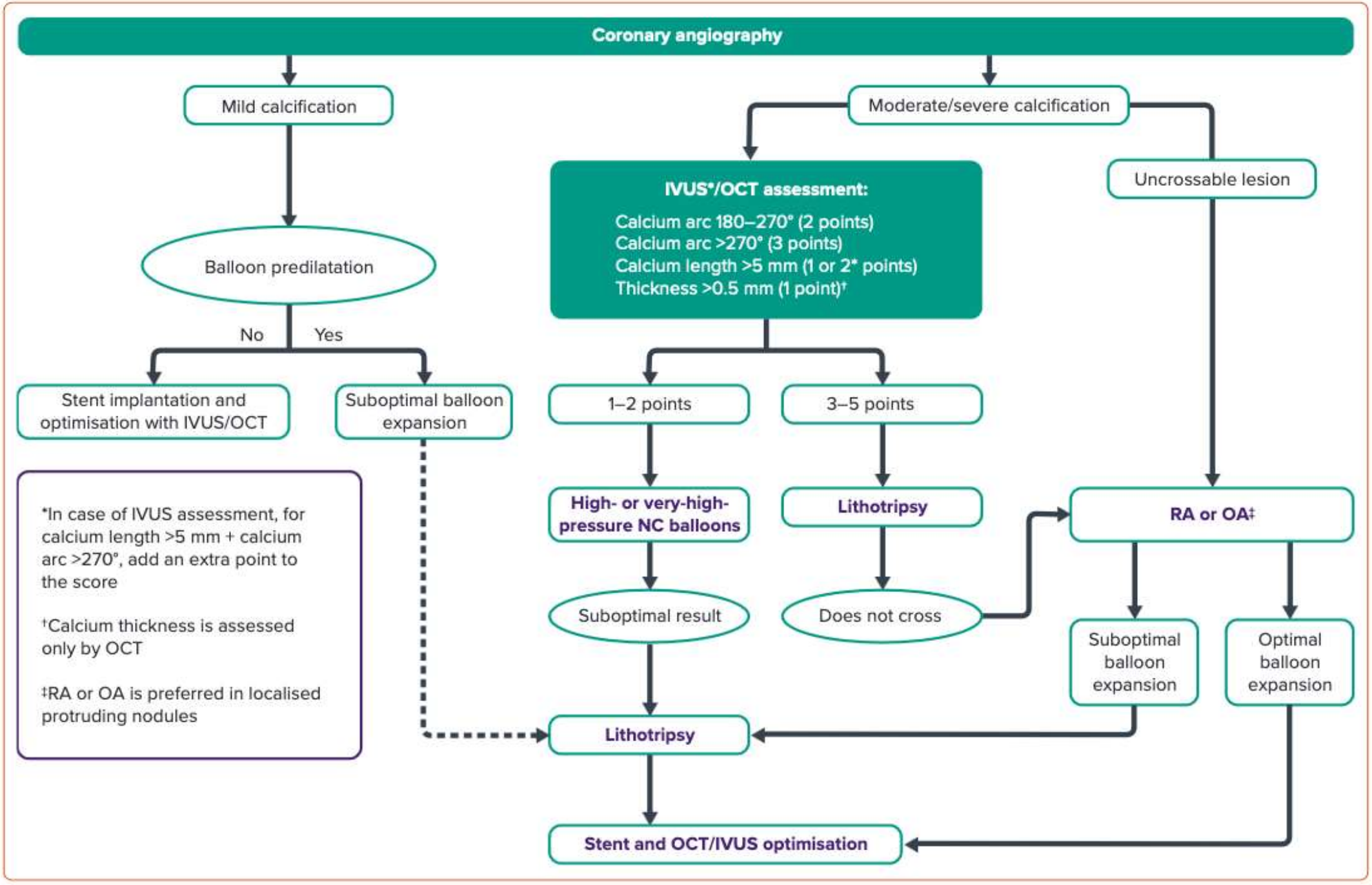
Subsidy status

Coronary IVL is not recommended for subsidy in patients with the abovementioned indications.

Published on 6 June 2022

- Available for clinical use
- Based on the:
  - limited low-quality non-comparative clinical evidence,
  - the lack of economic evidence, and
  - ongoing RCTs comparing coronary IVL with standard calcium modification treatment,

subsidy not recommended for coronary IVL



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Interventional Cardiology 2022;17:e02. DOI: https://doi.org/10.15420/icr.2021.14

Conclusion

- I V L is an adjunct for PCI in calcified lesions
- Small non comparative studies suggest safety and ease of use
- Efficacy appears to be good
- Place in the algorithm needs to be defined
- Cost-effectiveness needs to be established