



Resténose & Thrombose de stent Pourquoi l'imagerie est indispensable?

**Géraud SOUTEYRAND
CHU Clermont-Ferrand**



Conflits d'intérêts

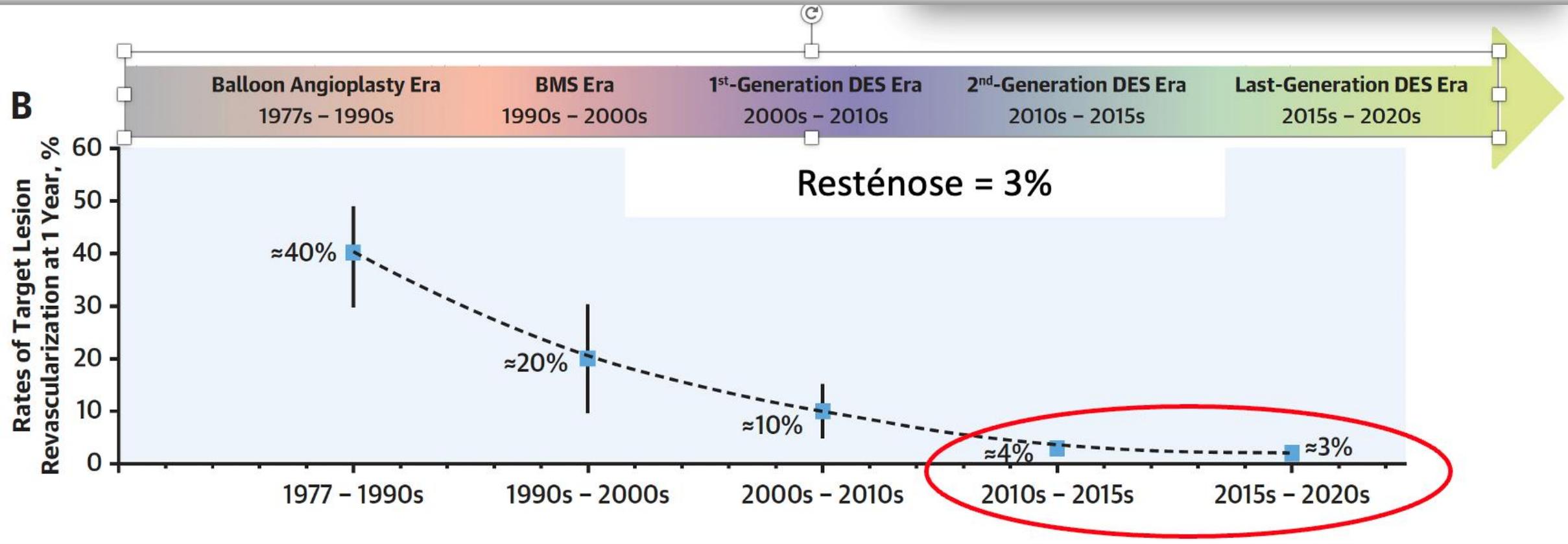
Consultant Terumo, Medtronic, Abbott, B Braun, Schockwave

Est-ce fréquent?

Resténose intrastent

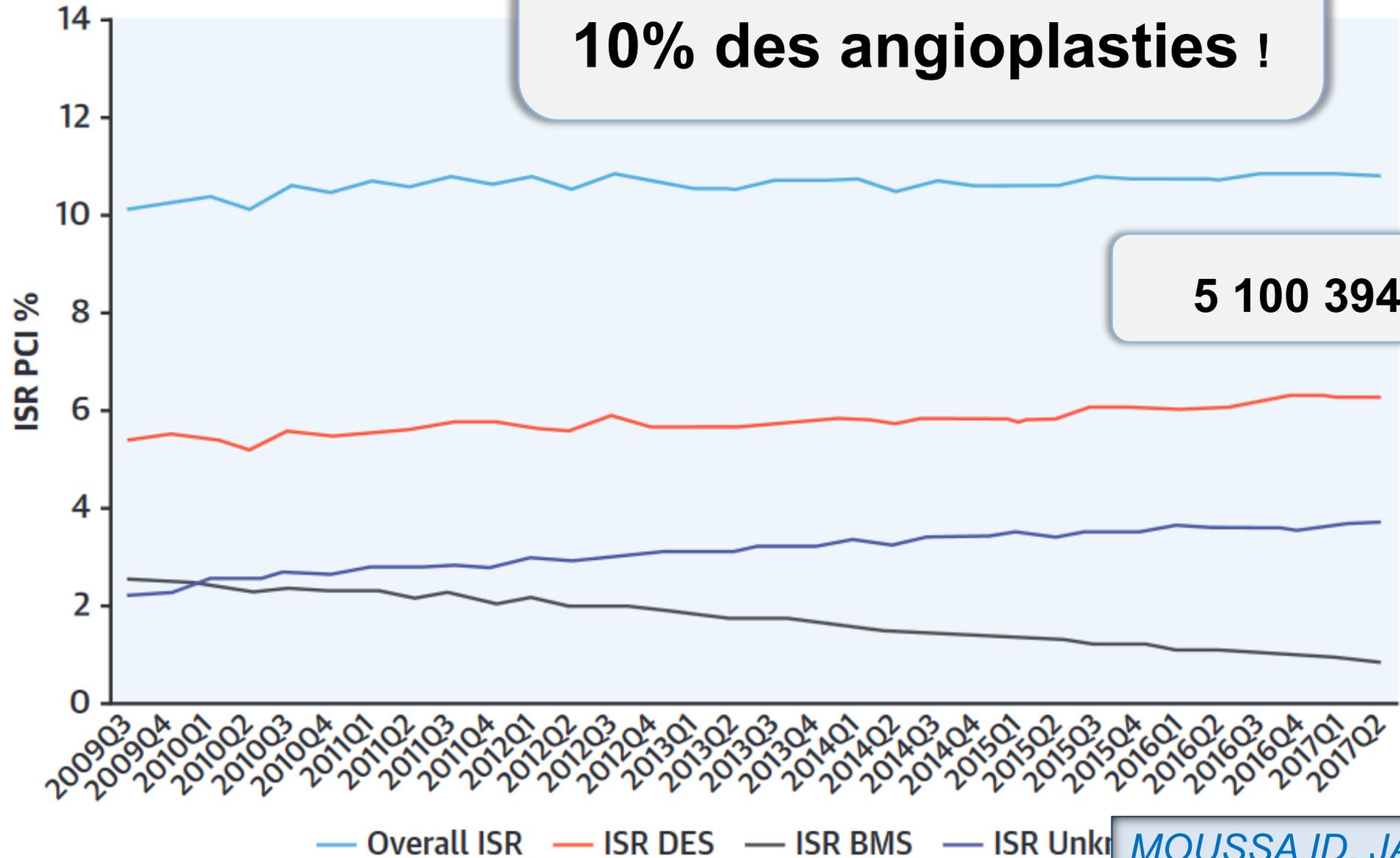
Coronary In-Stent Restenosis

JACC State-of-the-Art Review



Resténose intrastent

Registre américain
10% des angioplasties !



Resténose intrastent

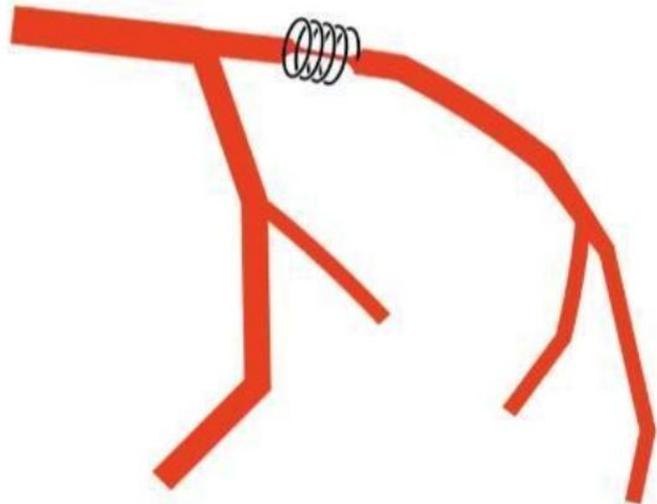
Données France PCI

(2014-2018)

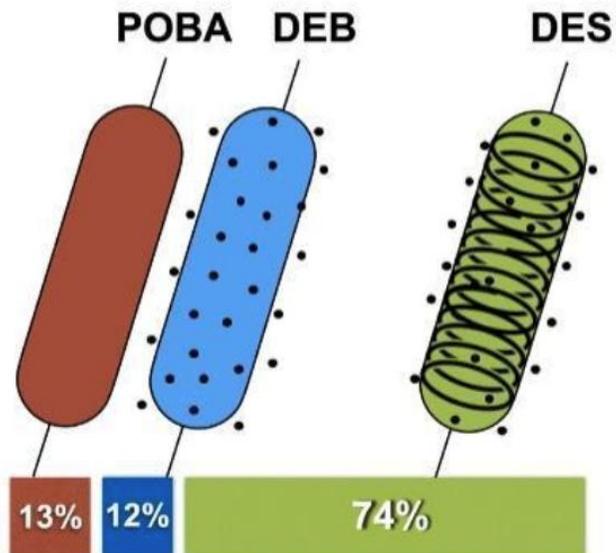
31 892 lésions

Prevalence

ISR = 7.3% of PCI



Management

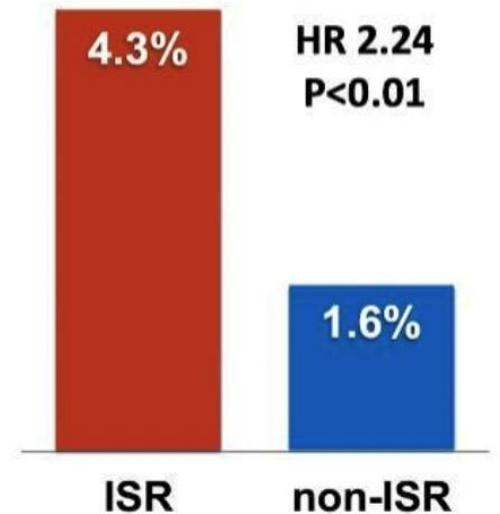


Intracoronary Imaging = 1.9%



Outcomes

TLR within 12 months



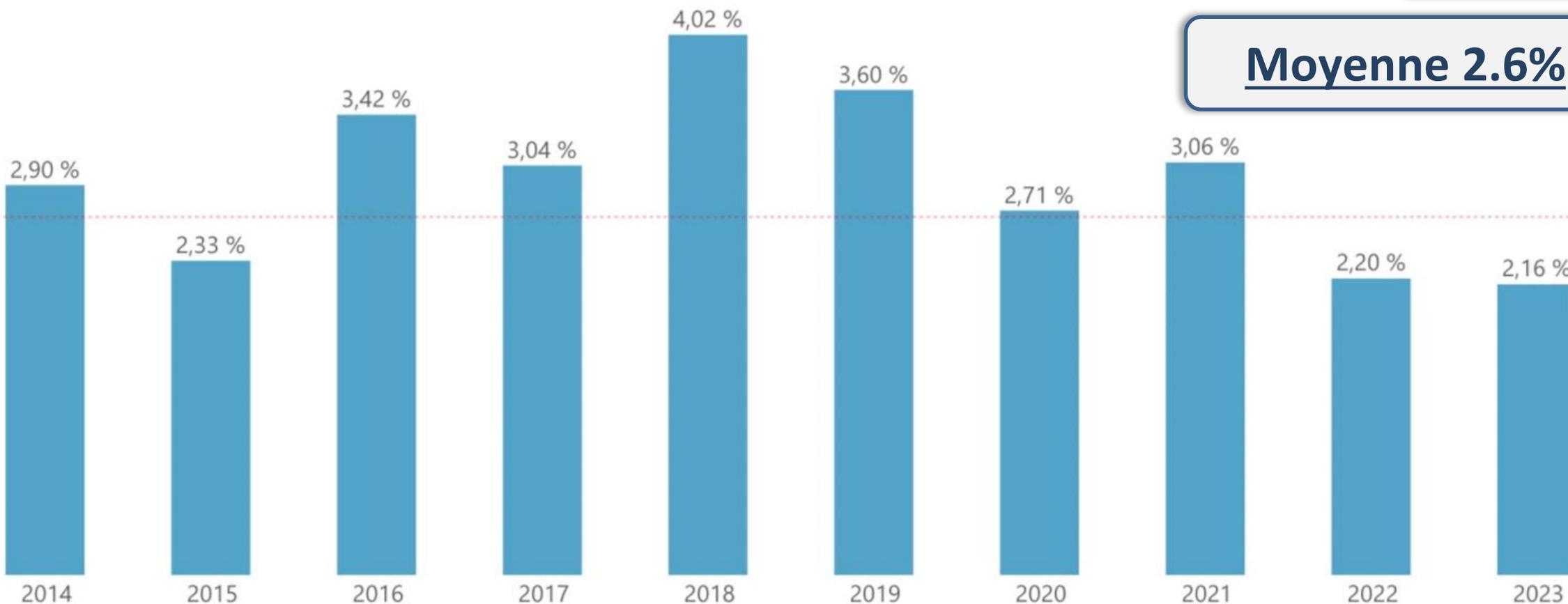
Resténose intrastent

Données France PCI



Utilisation imagerie endocoronaire dans RIS

Moyenne 2.6%



Merci G.RANGE

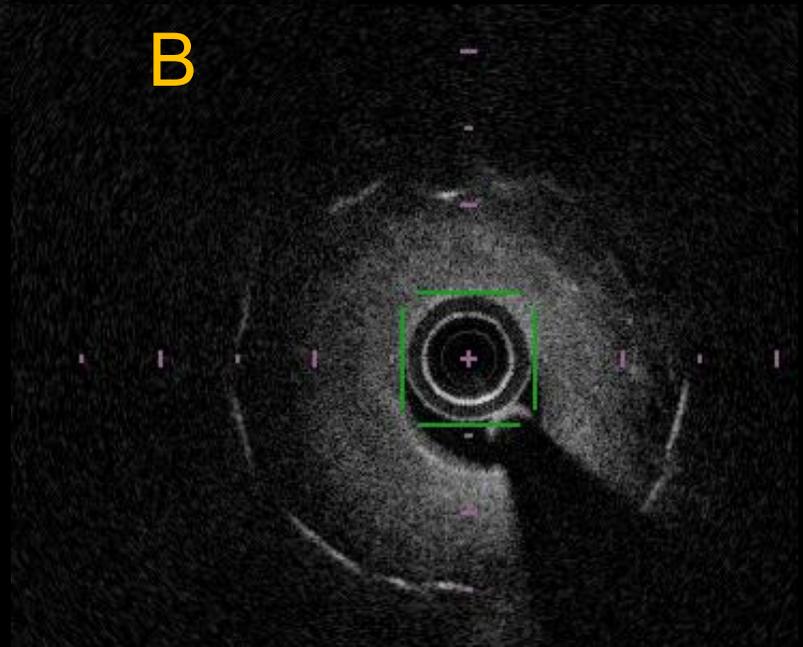
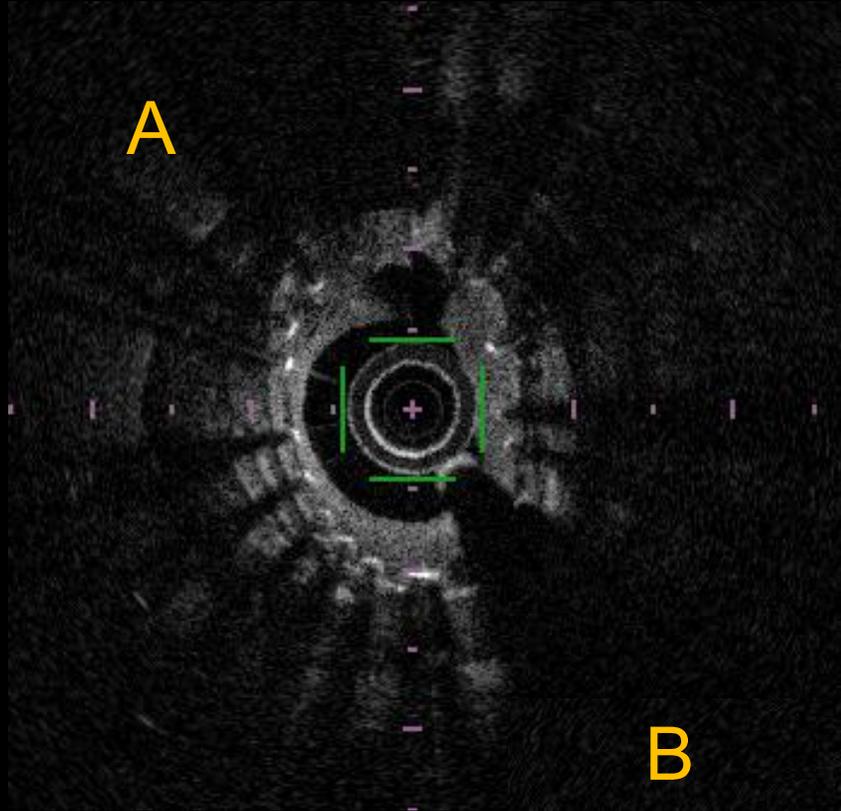
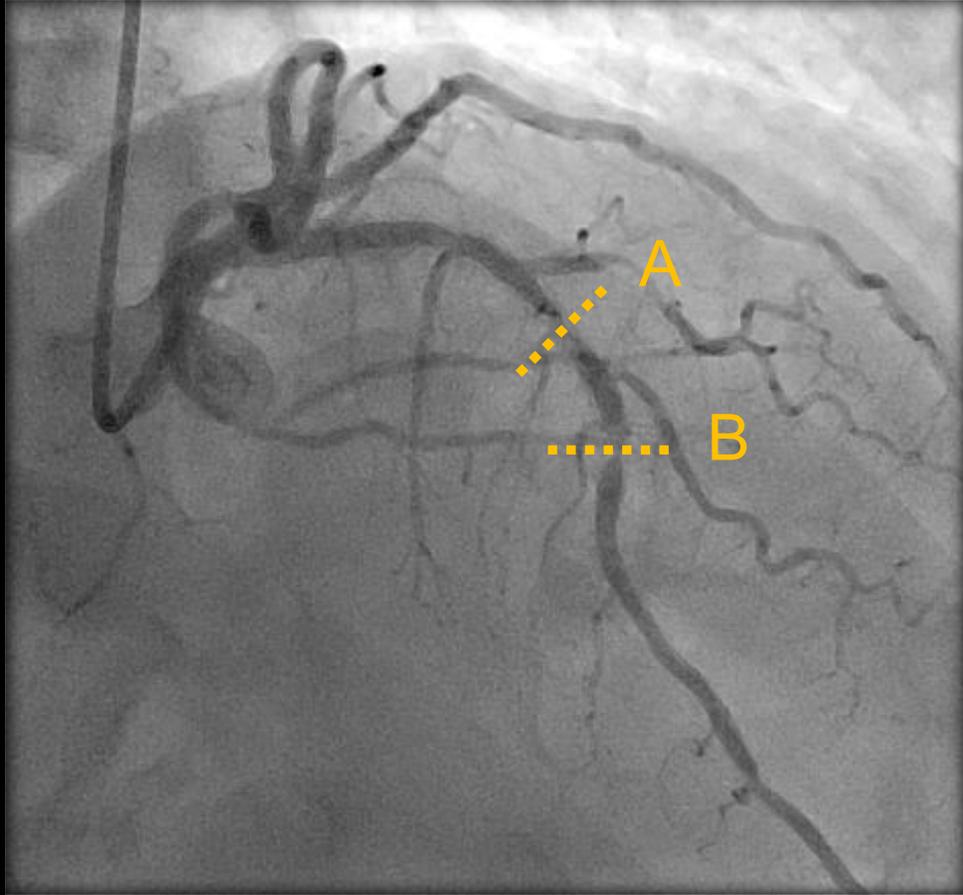
Resténose intrastent

**Pourquoi faire de l'imagerie
endocoronaire?**

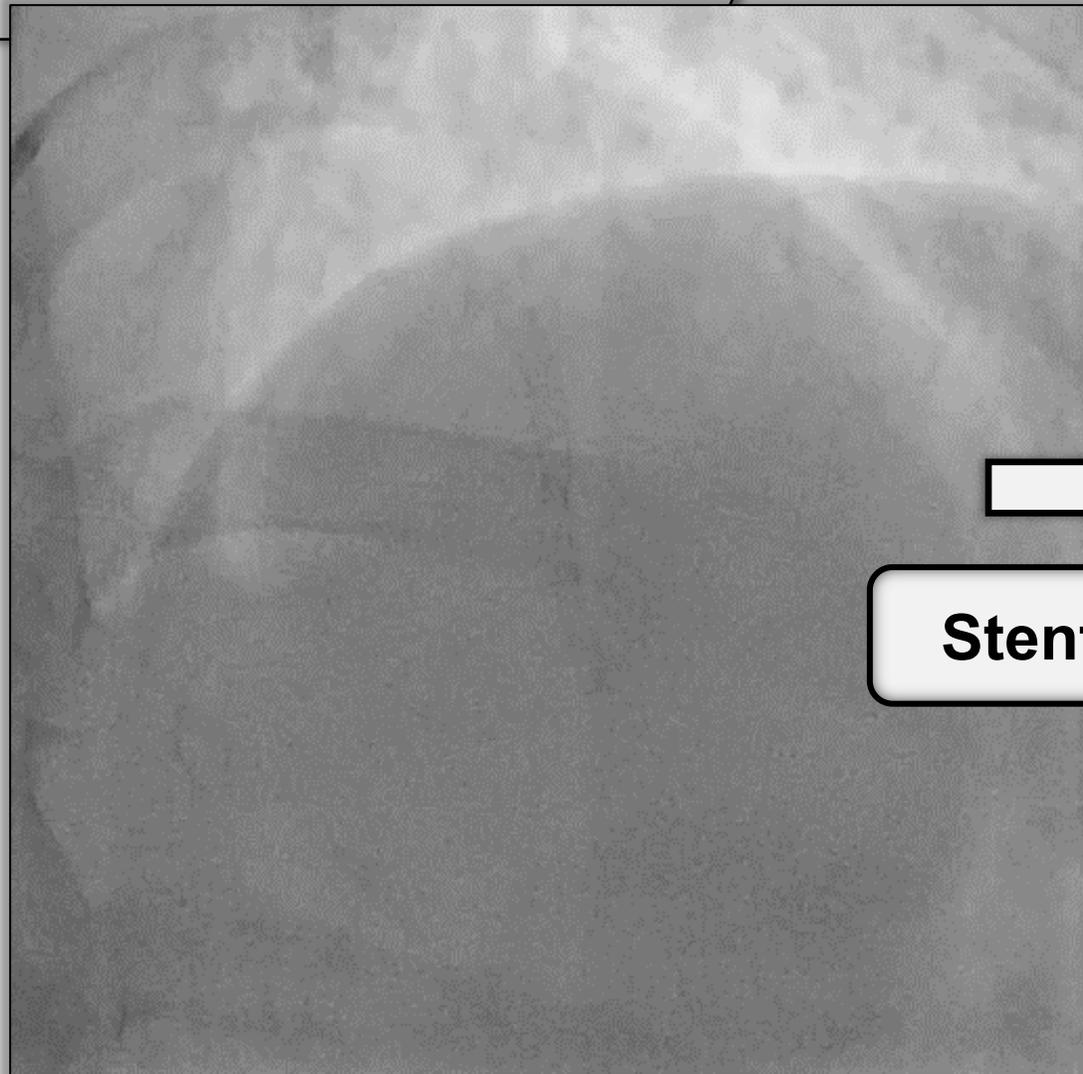
Resténose intrastent

H. 64 ans
Angioplastie en 2014
Angor d'effort

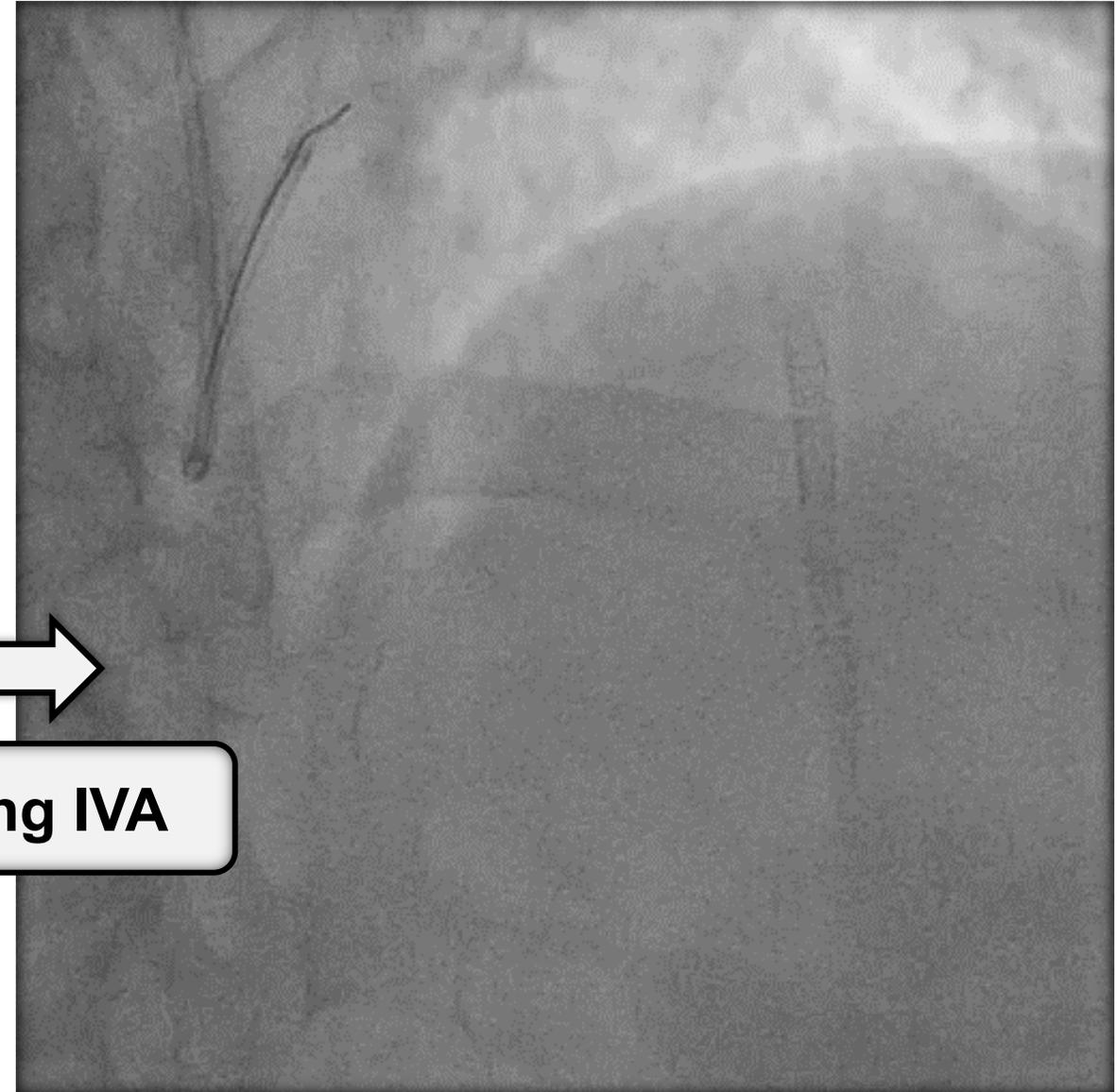




Mr JH 55 ans
ATCD stenting
Avril 2023



Stenting IVA

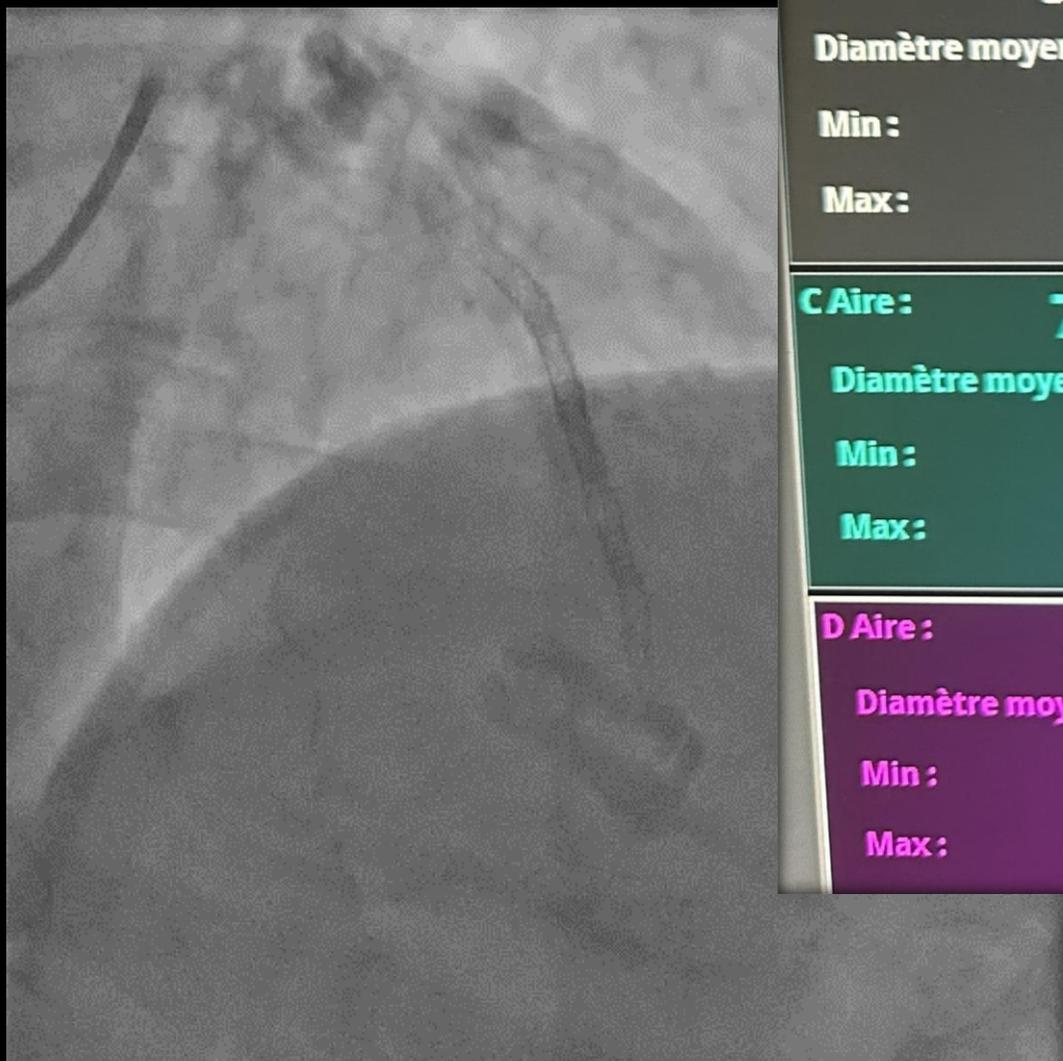


Revient 6 mois + tard
Reprise angor effort

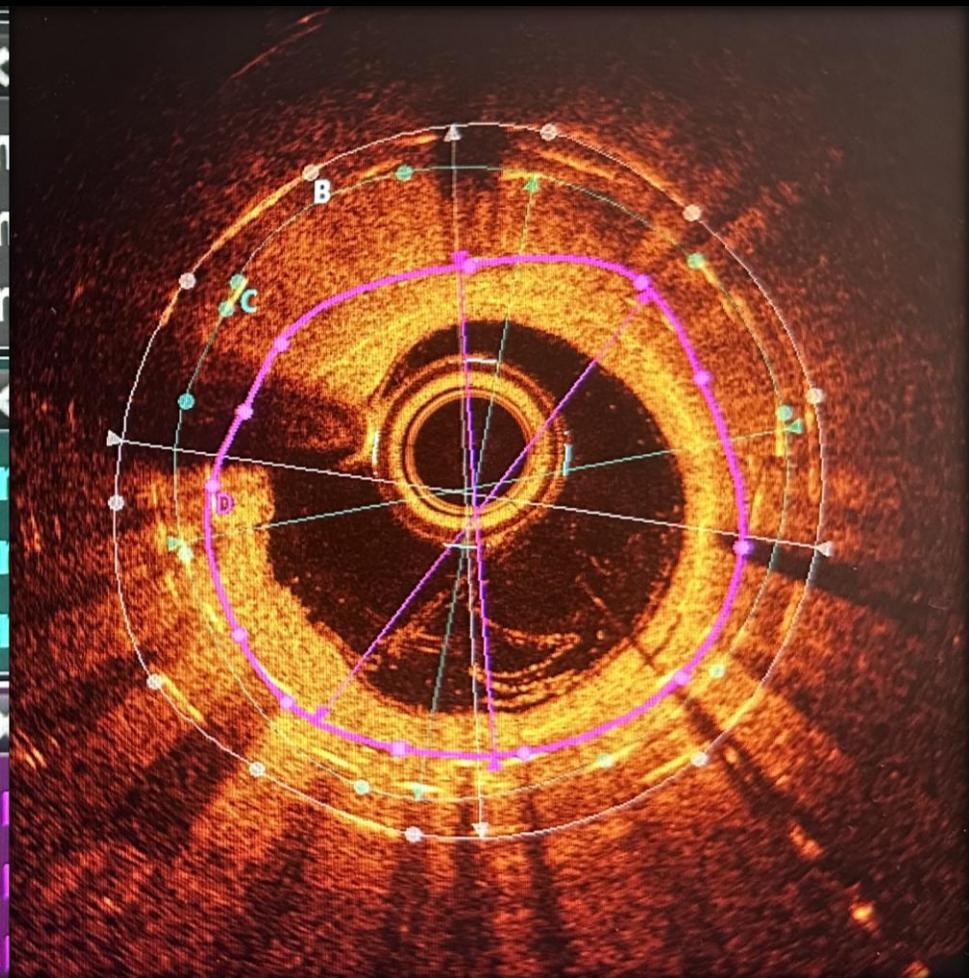


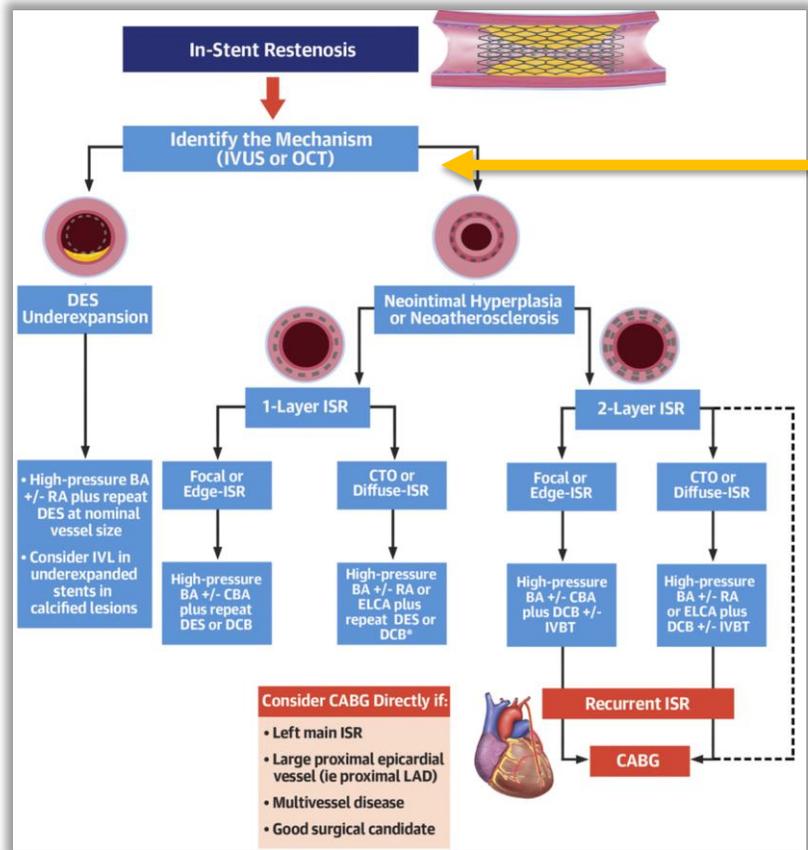
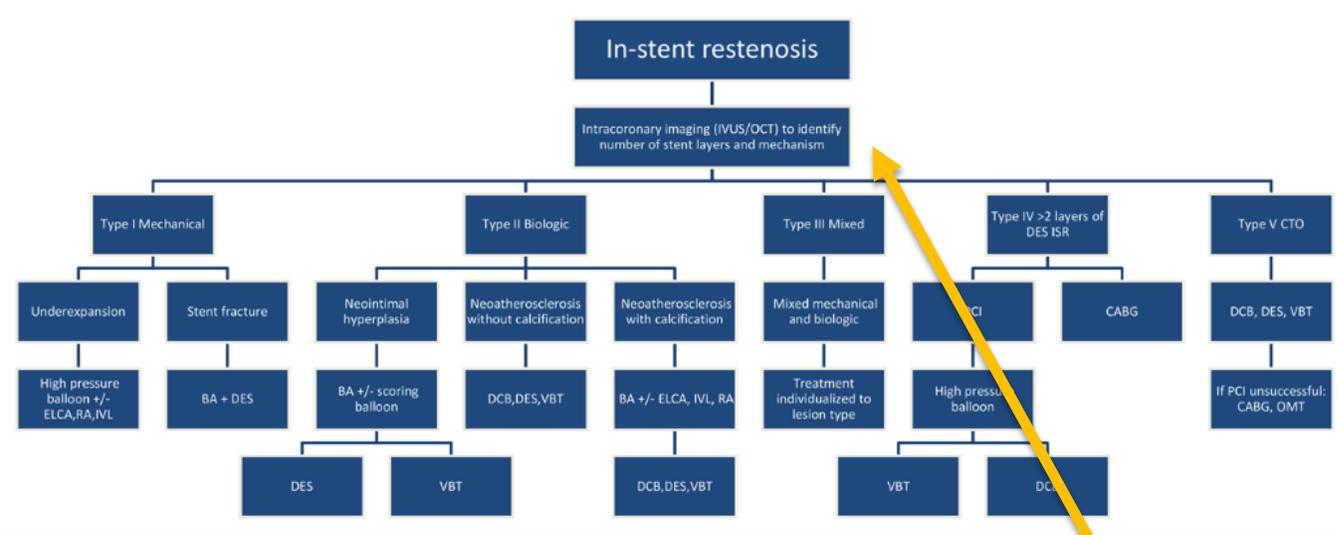
Revient 6 mois + tard

Reprise angor effort

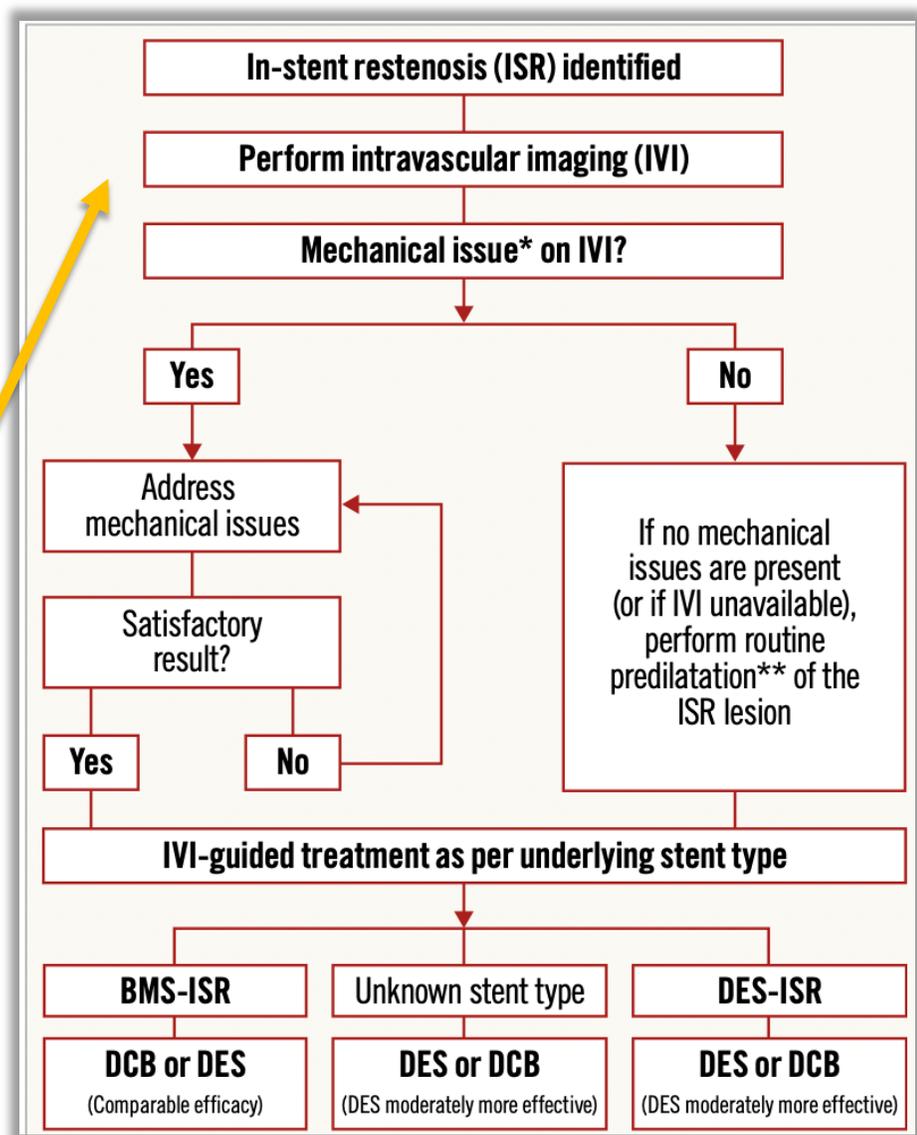


B Aire :	9.22mm ²	×
Diamètre moyen :	3.42 mm	
Min :	3.37 mm	
Max :	3.47 mm	
C Aire :	7.03mm ²	×
Diamètre moyen :	2.99 mm	
Min :	2.91 mm	
Max :	3.08 mm	
D Aire :	4.94mm ²	→
Diamètre moyen :	2.51 mm	
Min :	2.40 mm	
Max :	2.61 mm	





Faire de l'imagerie endocoronaire



GIUSTINO G. JACC 2022
 Waksman R. Circ Interv 2019
 Alfonso F. Eurointervention 2022

Resténose intrastent

Quel type de resténose??

307 patient with stent restenosis 297 OCT analysées

Dec 2019- June 2021 : n= 450 patients screened for inclusion

N=104 patients did not meet inclusion criteria

N=39 patients did not consent

n= 307 patients consented

N=2 patients with lesion crossing failure by OCT

n= 305 patients with initial pre-PCI OCT analysis

N=8 patients with inadequate OCT quality

n= 297 patients with analysable pre-PCI OCT

N=25 patients with no post PCI OCT run

N= 19 patients with inadequate post PCI OCT quality

n= 254 patients with analysable post-PCI OCT

Critères non-inclusion

- STEMI
- Choc cardiogénique
- Impossibilité technique faire OCT,
- Pré-dilatation avec ballon > 2mm
- Femme enceinte

Caractéristiques Population

Population

Age, année

70.0 (62.5-75.7)

Genre masculin, n(%)

239 (81%)

Diabète, n(%)

129 (43%)

Tabac actif, n(%)

55 (19%)

Dyslipidemie, n(%)

248 (84%)

LDL-Chol <0.7 g/l , n(%)

92 (31%)

Délai entre ATL initiale et RIS, mois

64.8 (17.4-142.2)

SCA, n (%)

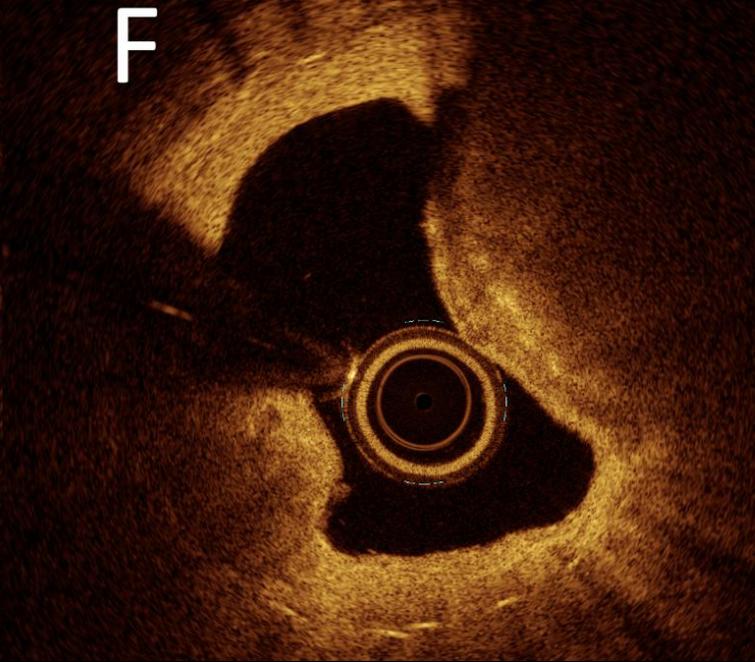
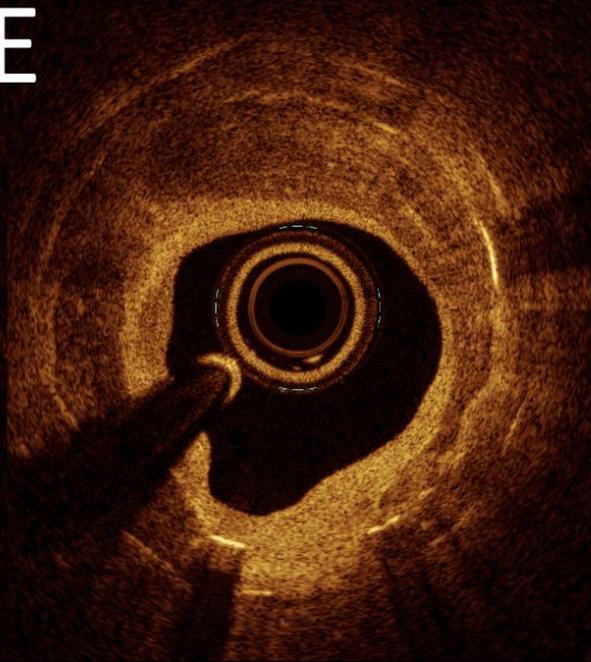
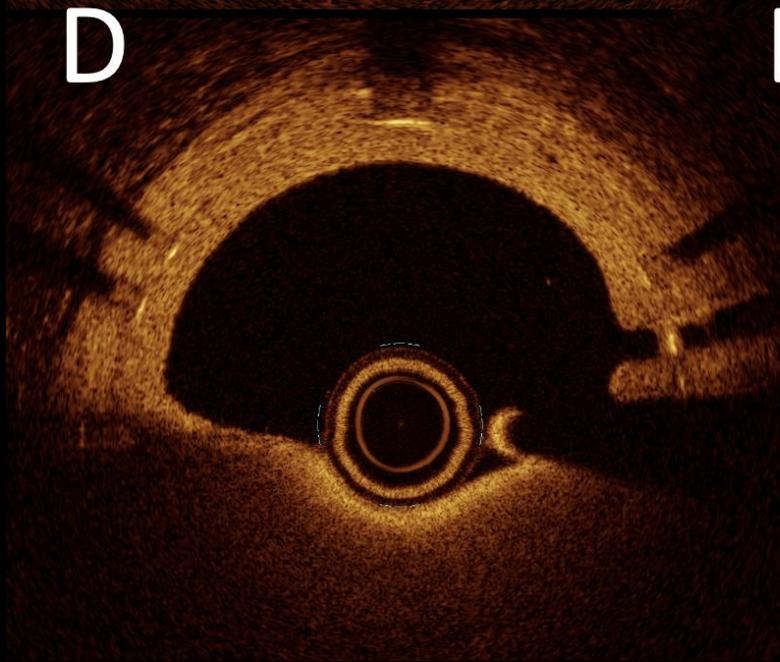
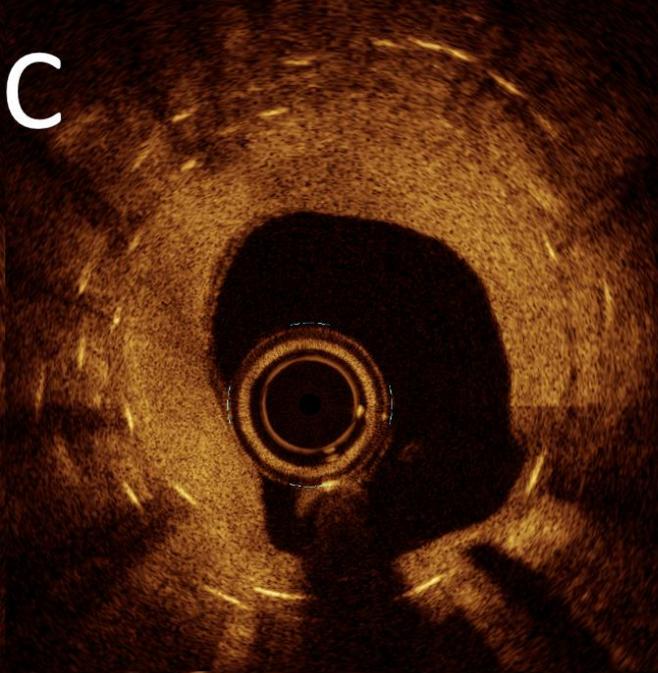
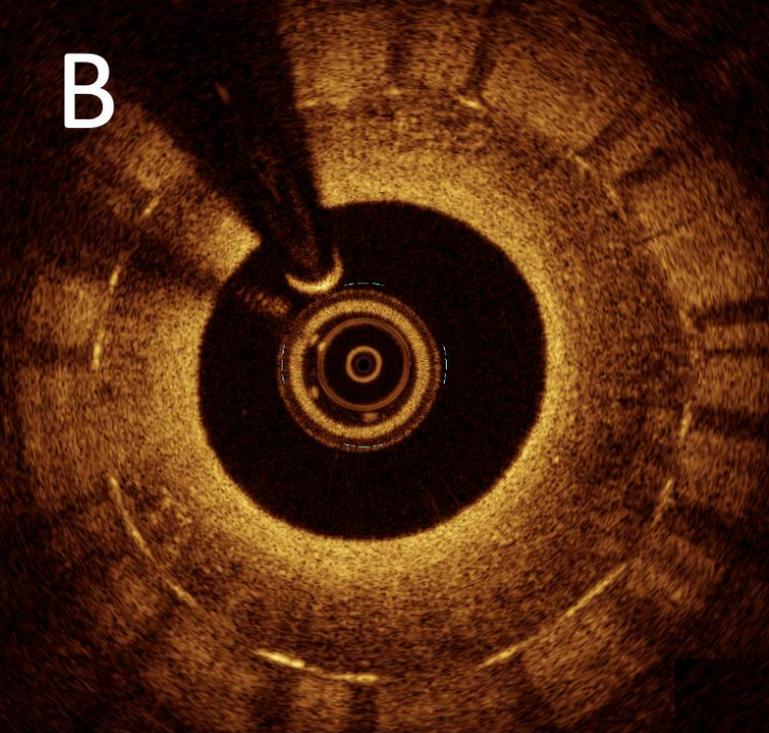
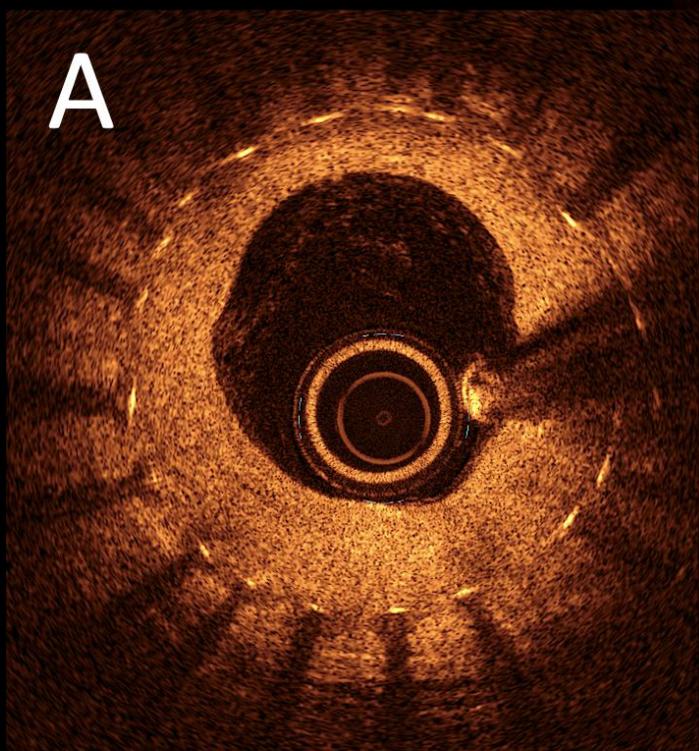
110 (37%)

Stent actif

221 (74%)

Localisation stent : IVA, Cx, Cdte

145 (48%), 52 (18%) , 94 (31%)



Imagerie endocoronaire & RIS

**Combien de couches de stents
Existe-t-il un facteur
mécanique?**

Imagerie endocoronaire & RIS

Recherche causes mécaniques



Stent factors

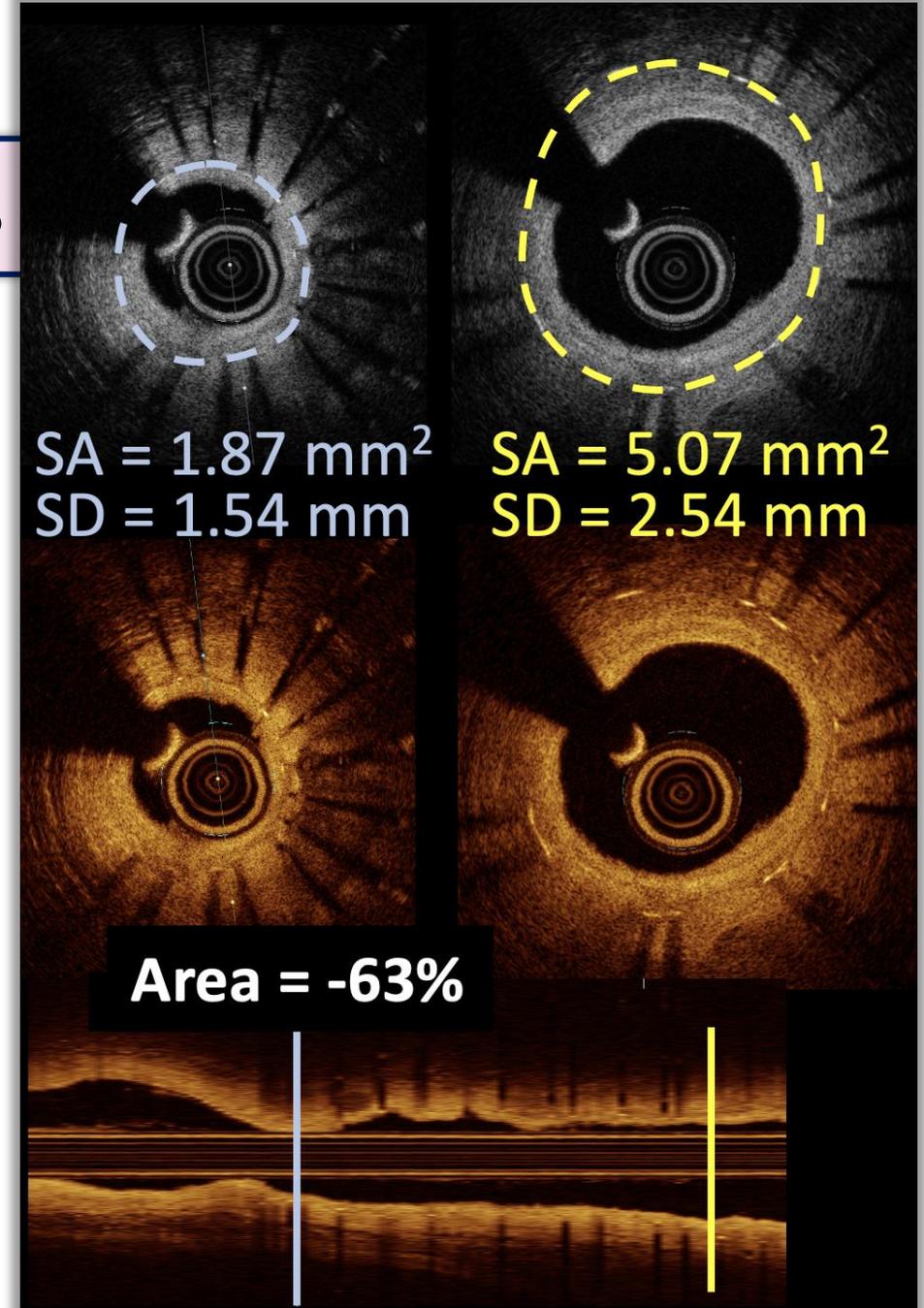
- Underexpansion
- Undersizing
- Fracture/Gap
- Stent type
- Edge restenosis

Intra-stent factors

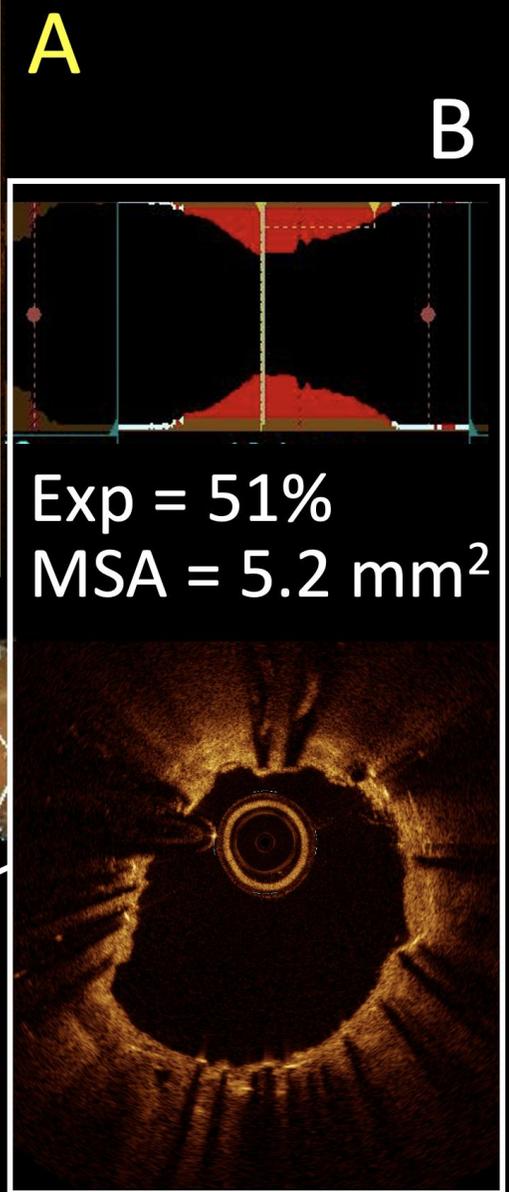
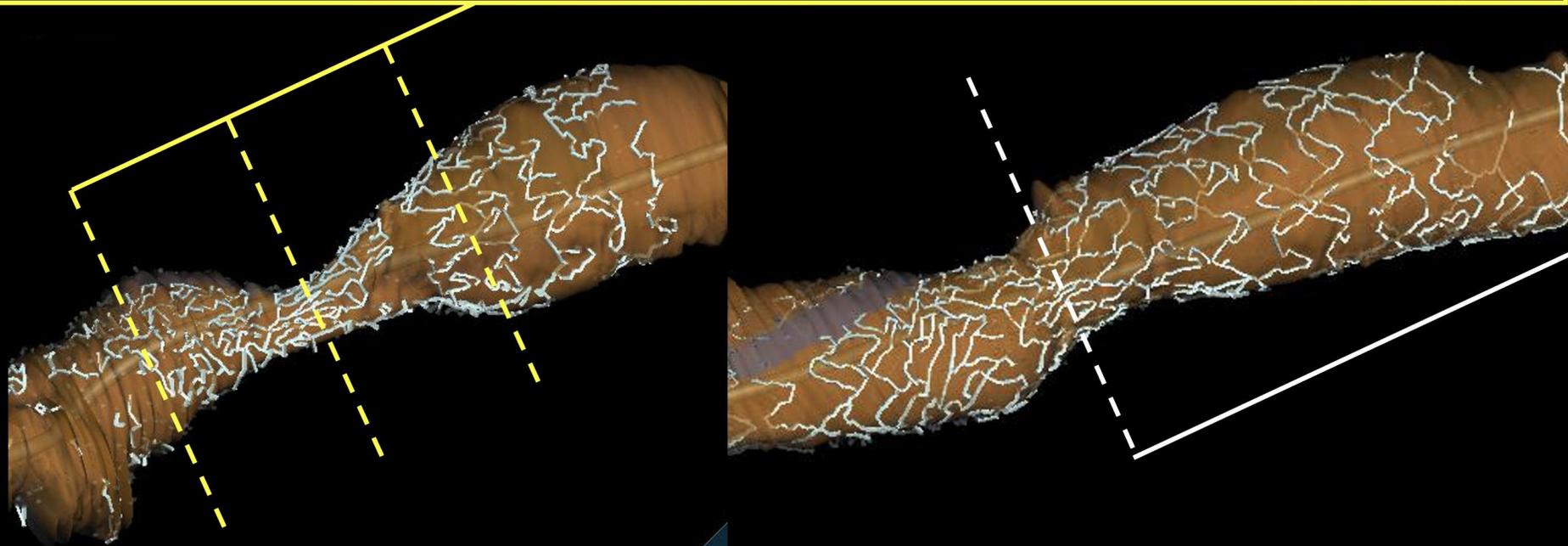
- Neointimal hyperplasia
- Neoatherosclerosis
- Calcification/Thrombus
- Hetero/Homogenous tissue
- Focal/Diffuse pattern
- Obstruction severity

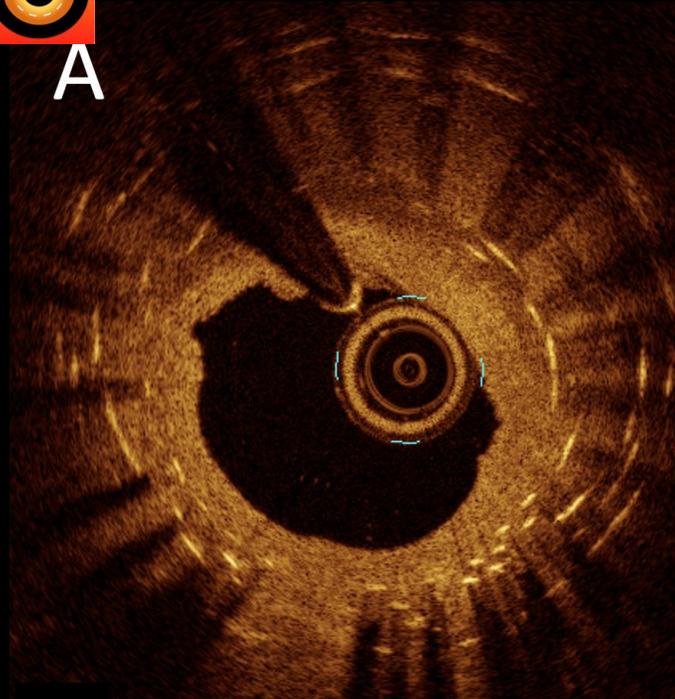
Extra-stent factors

- Multiple stent layers
- Vessel calcification
- Calcified nodules
- Vessel size
- Residual plaque burden

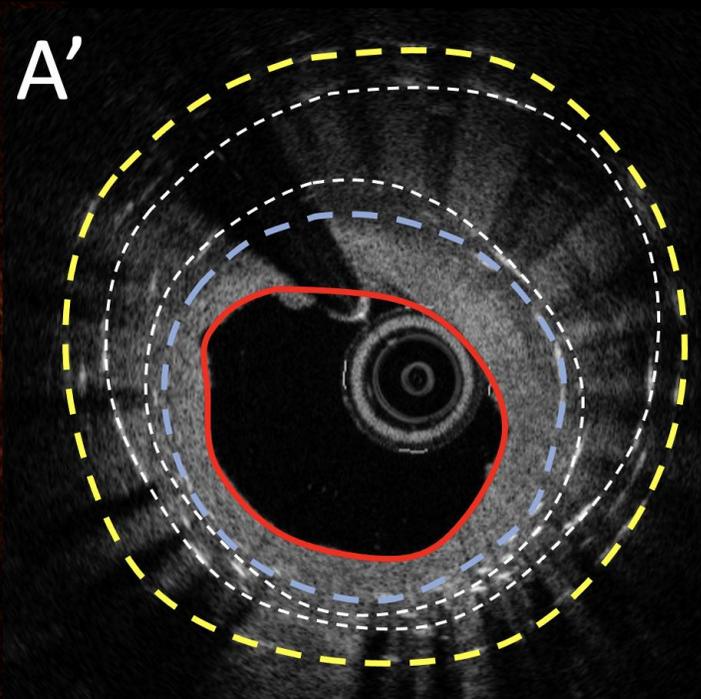


Analyse OCT(n=297)	n=297 (%)
Thrombus, n(%)	43 (14)
Aspect focal, n(%)	103 (34)
Aspect diffus, n(%)	194 (66)
Stents multicouches, n(%)	90 (30)
Longueur lésion, mm	16.4 (10-23.5)
Surface minimale lumière, mm ²	1.5 (1.1-2.2)
Epaisseur maximale néointimale, µm	870 (612-1150)
Surface Référence, mm ²	6.4 (5.1-8.2)
Min. stent diamètre, mm	2.6 (2.3-2.9)
Min. stent surface, mm ²	4.8 (3.7-6.1)
Stent expansion (%)	75 (62-89)
Sous Expansion (MSA), n(%)	129 (43)





A

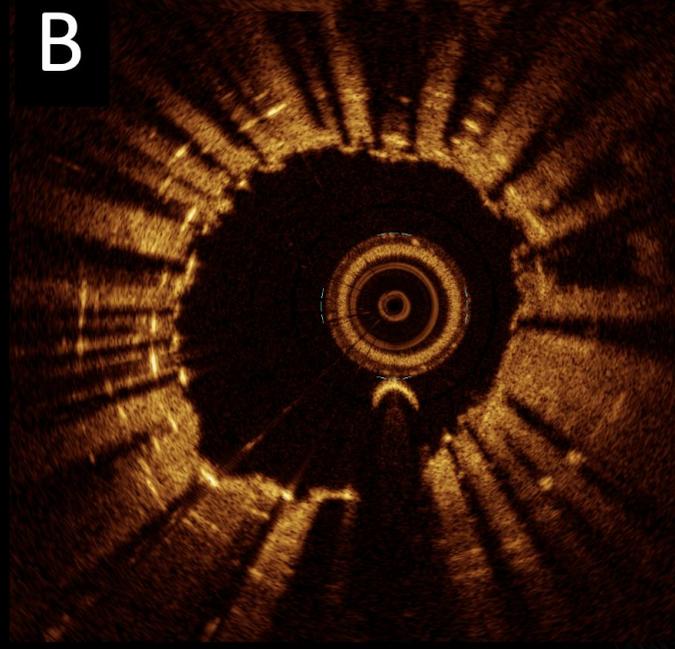


A'

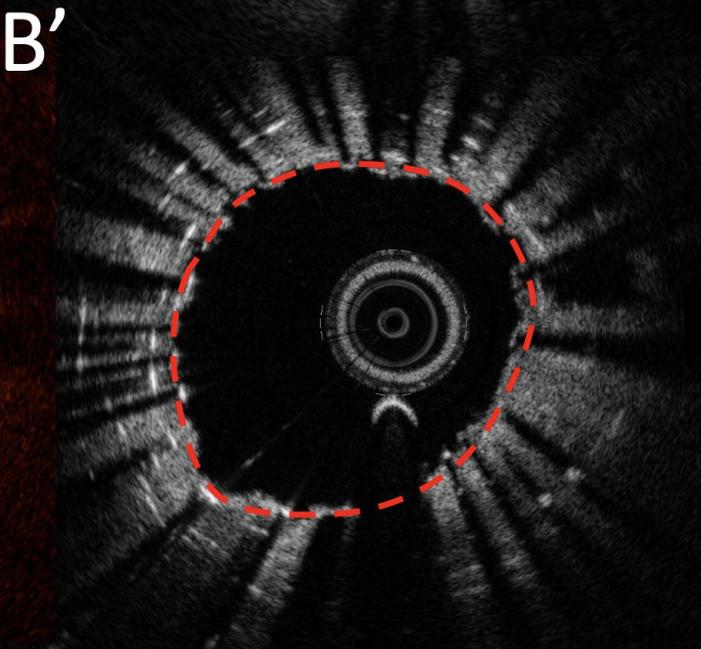
MLA = 2.52 mm²
MLD = 1.78 mm

S₄A = 4.28 mm²
S₄D = 2.33 mm

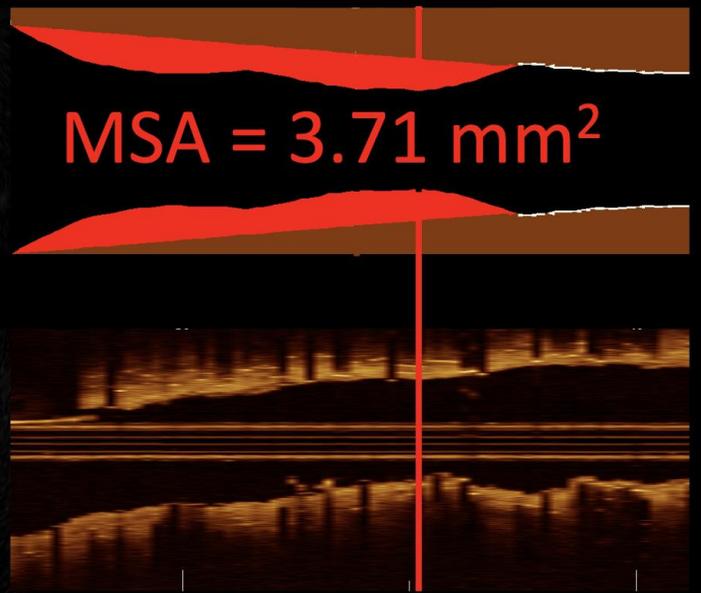
S₁A = 10.2 mm²
S₁D = 3.61 mm



B



B'



Imagerie endocoronaire & RIS

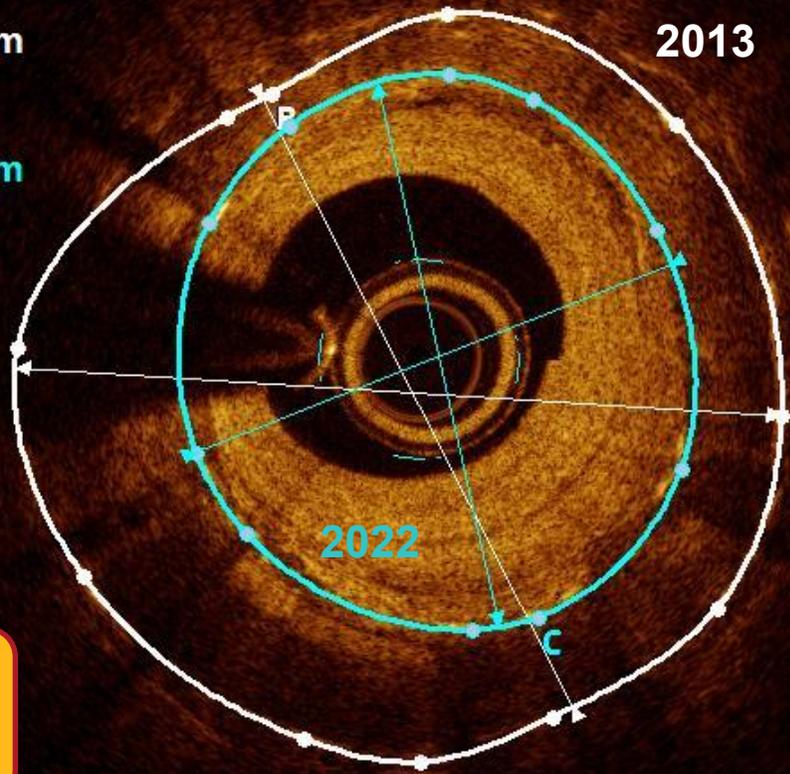
Est-ce que ça change quelque chose?

Nombre de couches

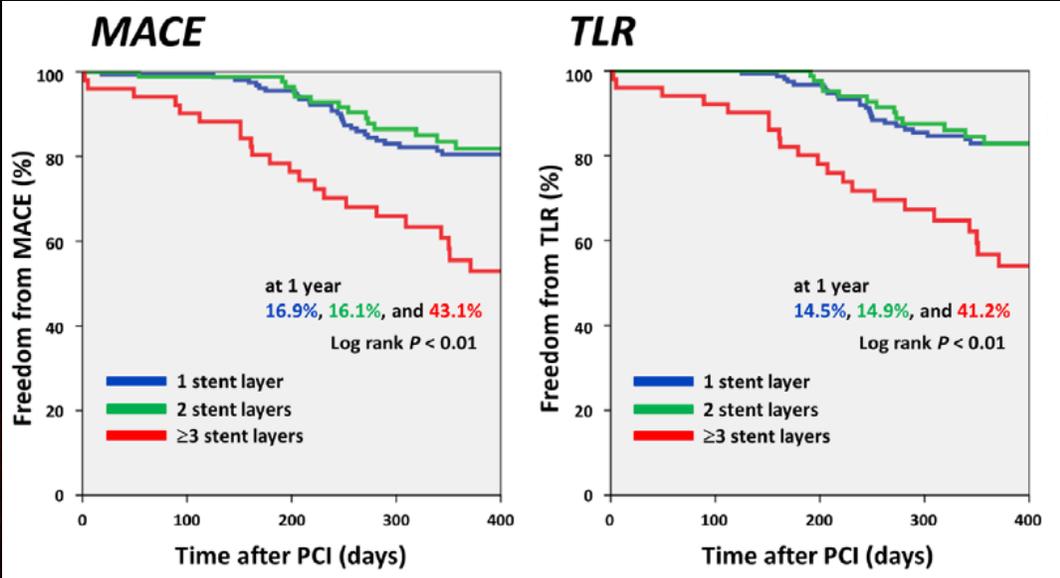
- A Aire : 1.51mm²**
Diamètre moyen : 1.39 mm
Min : 1.35 mm Max : 1.41 mm
- B Aire : 8.91mm²**
Diamètre moyen : 3.36 mm
Min : 3.12 mm Max : 3.51 mm
- C Aire : 4.66mm²**
Diamètre moyen : 2.43 mm
Min : 2.33 mm Max : 2.55 mm

30% multicouches

Evolution taille stents



304 patients entre 2014 et 2015 avec resténose intrastent



**Predictors and outcomes of neoatherosclerosis in patients
with in-stent restenosis**

**313 lésions avec resténose intrastent
2009-2017 avec OCT
64 BMS (20%) 241 DES (77%)**

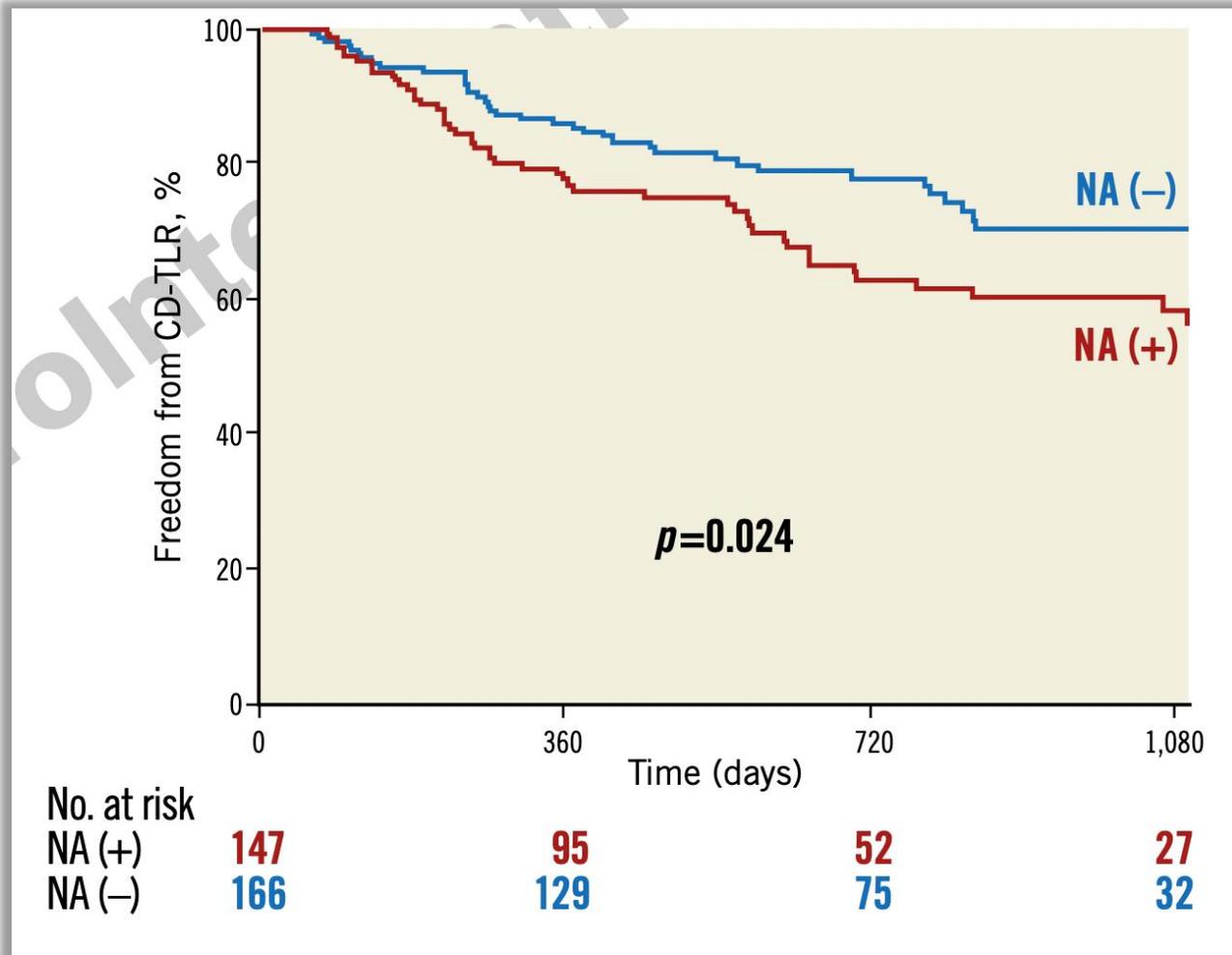
47% néoathérosclérose en OCT
Ins rénale/DES & délai resténose en faveur

**Predictors and outcomes of neoatherosclerosis in patients
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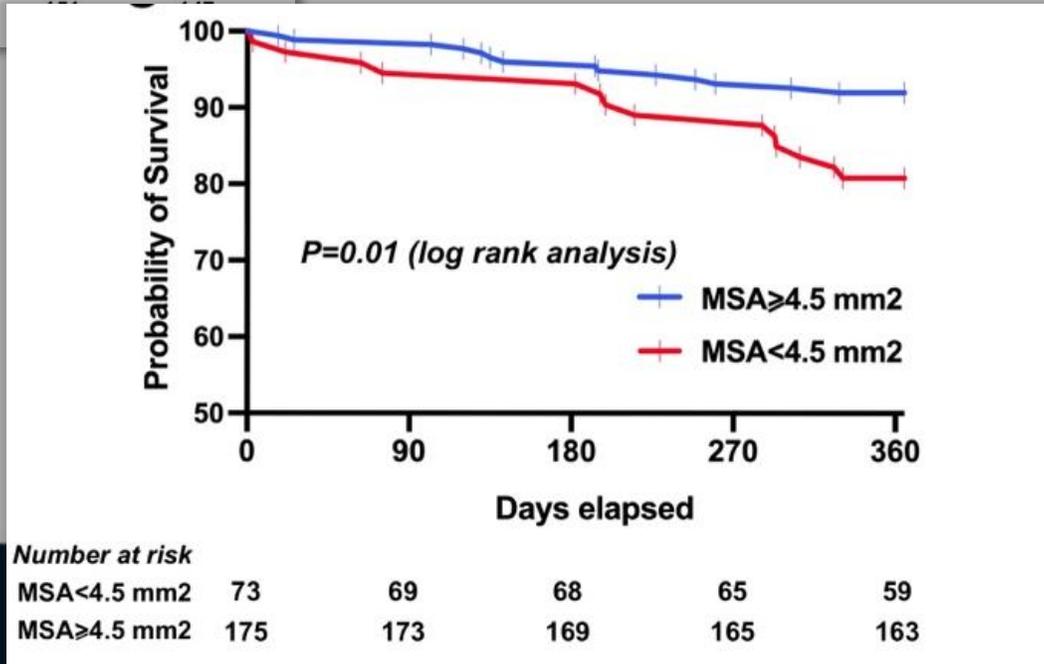
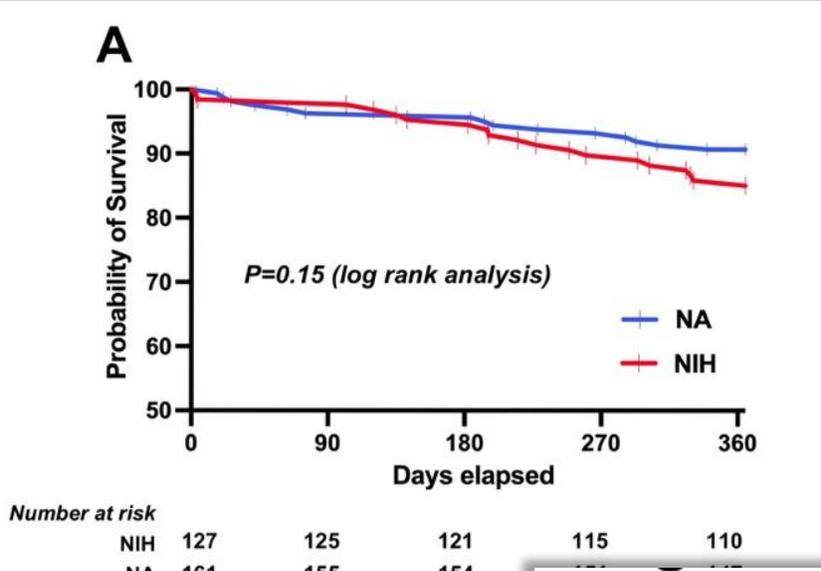
Predictors and outcomes of neoatherosclerosis in patients with in-stent restenosis



38 vs 23 % à 2 ans
Si néoathérosclérose

TRAITEMENT		n=297 (%)
	Stent actif, n(%)	159 (53)
	Ballon actif, n(%)	112 (38)
	Ballon seul, n(%)	8 (3)
	DEB+ DES, n(%)	16 (5)
	Chirurgie, n(%)	2 (1)
	Diamètre stent actif (mm)	3.0 (2.75-3.5)
	Longueur stent actif (mm)	24 (16-36)
	Diamètre ballon actif (mm)	3.0 (3.0-3.5)
	Longueur ballon actif(mm)	20 (20-30)
	Intravascular lithotripsie, n(%)	7 (2)
	Rotational atherectomie n(%)	2 (1)
Post treatment QCA analysis	Sténose résiduelle (%)	17.6 (13.3-22.1)
	Diamètre résiduel minimum, mm	2.68 (2.35-2.98)

Analyse OCT post-angioplastie (n=254)	Surface minimale de lumière finale (mm²)	4.9 (3.8-6.5)
	Gain en surface(mm²)	3.2 (2.3-4.4)
	Dissection finale significative, n(%)	42 (16)
	Surface de stent finale(mm²)	5.6 (4.3-7.0)
	Gain en surface de stent(mm²)	0.74 (0-2.0)
	Expansion stent finale (%)	84 (75-94)
	MSA<4.5 mm², n(%)	73 (29)
	Expansion<80%, n(%)	87 (35)



Suivi à 1 an
 289 patients

42 MACES : 14.5%
 27 TVR : 9.3%
 non TVR infarction 3.5%
 5 décès : 1.7%

Imagerie endocoronaire & RIS

Stratégie thérapeutique

Imagerie endocoronaire & RIS

Recommandations ESC 2024

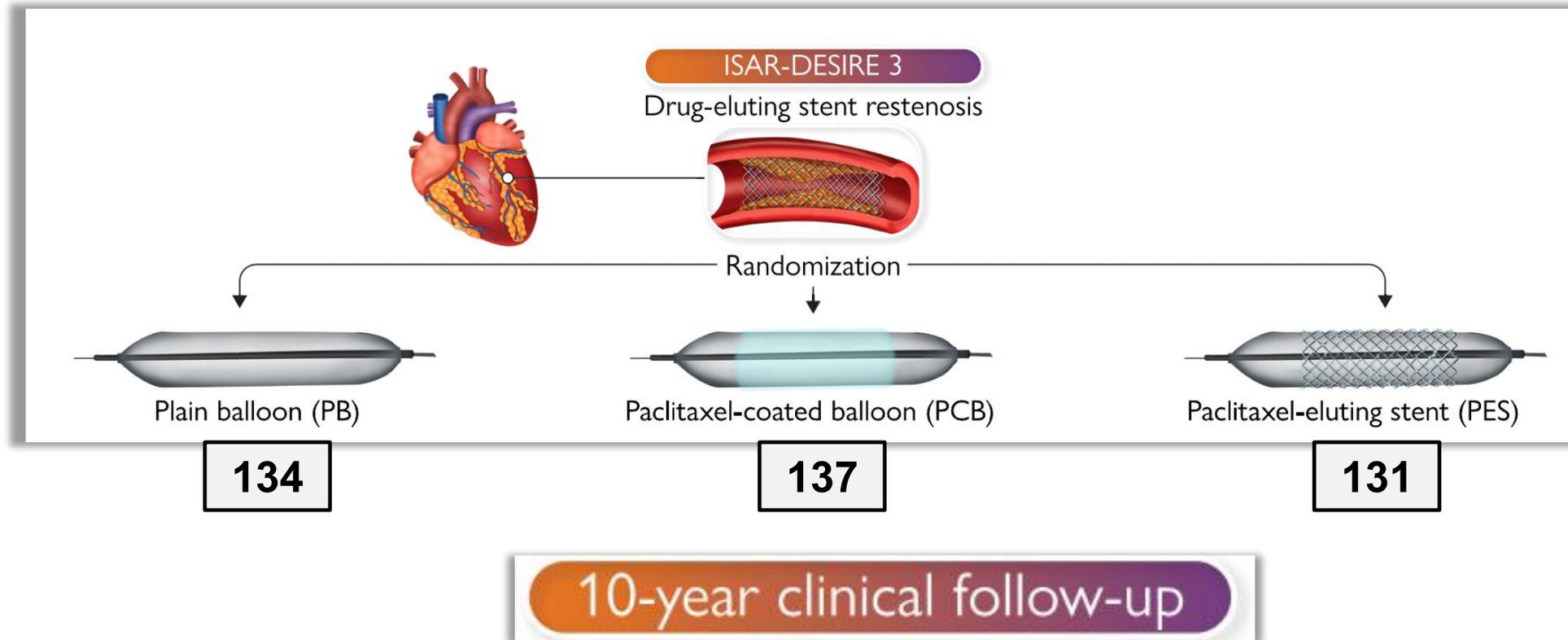
Recommendation Table 30 — Recommendations for treatment of revascularization failure (see also Evidence Table 30)

Recommendations	Class ^a	Level ^b
DES is recommended over drug-coated balloons for treatment of in-DES restenosis. ^{1186–1188}	I	A
LIMA is indicated as the conduit of choice for redo CABG in patients in whom the LIMA was not used previously. ¹¹⁹⁵	I	B
Redo CABG should be considered for patients without a patent LIMA graft to the LAD. ^{842,1192,1196}	IIa	B
PCI of the bypassed native artery should be considered over PCI of the bypass graft. ¹¹⁹⁷	IIa	B

RIS & traitement

Une lésion pas comme les autres

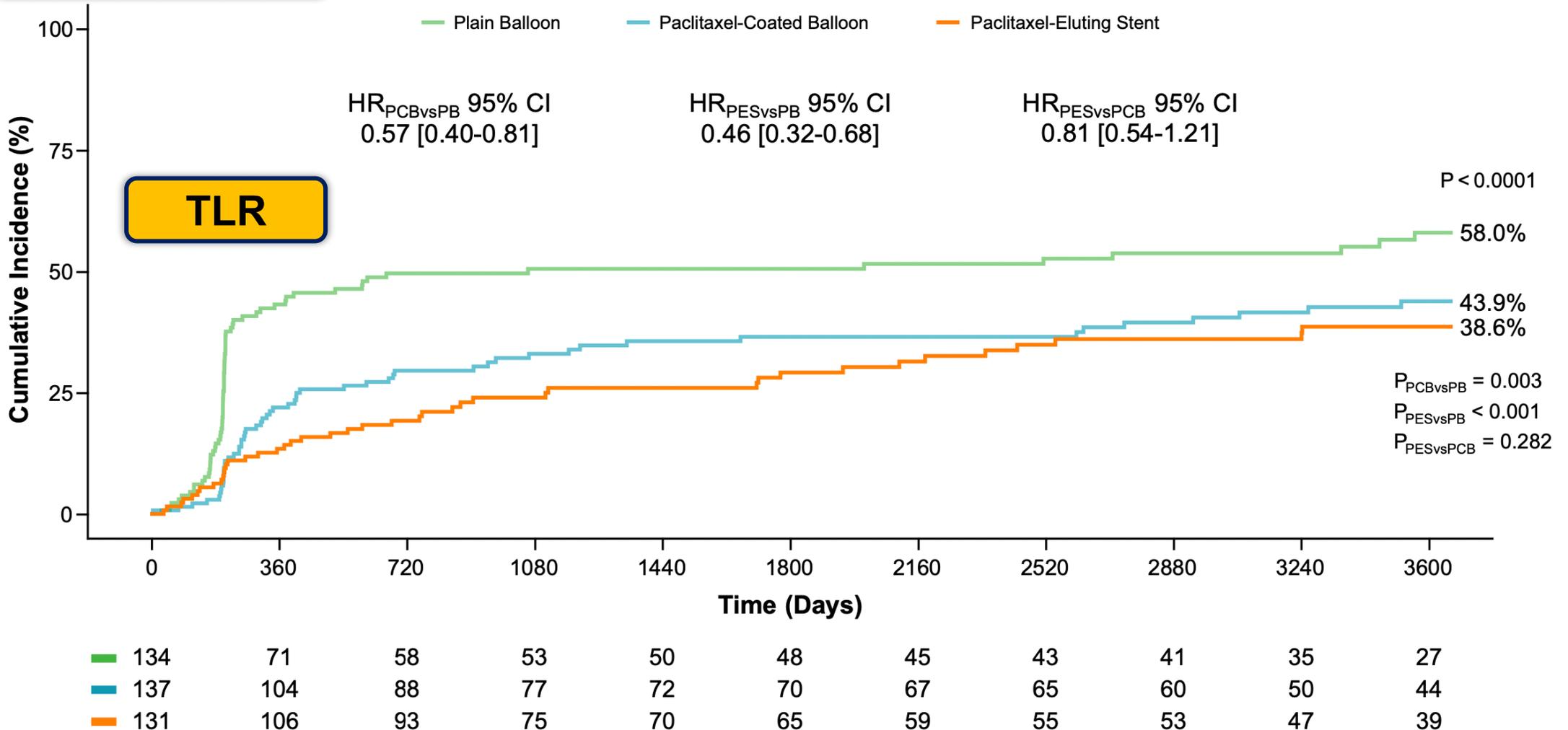
Coronary artery restenosis treatment with plain balloon, drug-coated balloon, or drug-eluting stent: 10-year outcomes of the ISAR-DESIRE 3 trial



RIS & traitement

ISARE DESIRE 3

Coronary artery restenosis treatment with plain balloon, drug-coated balloon, or drug-eluting stent: 10-year outcomes of the ISAR-DESIRE 3 trial

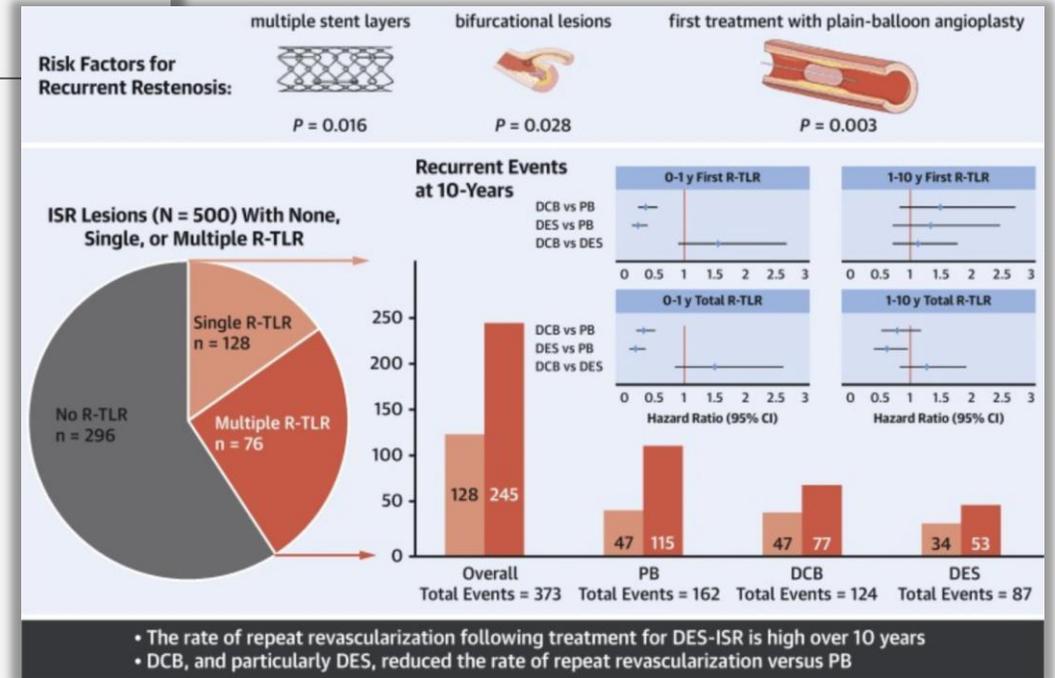
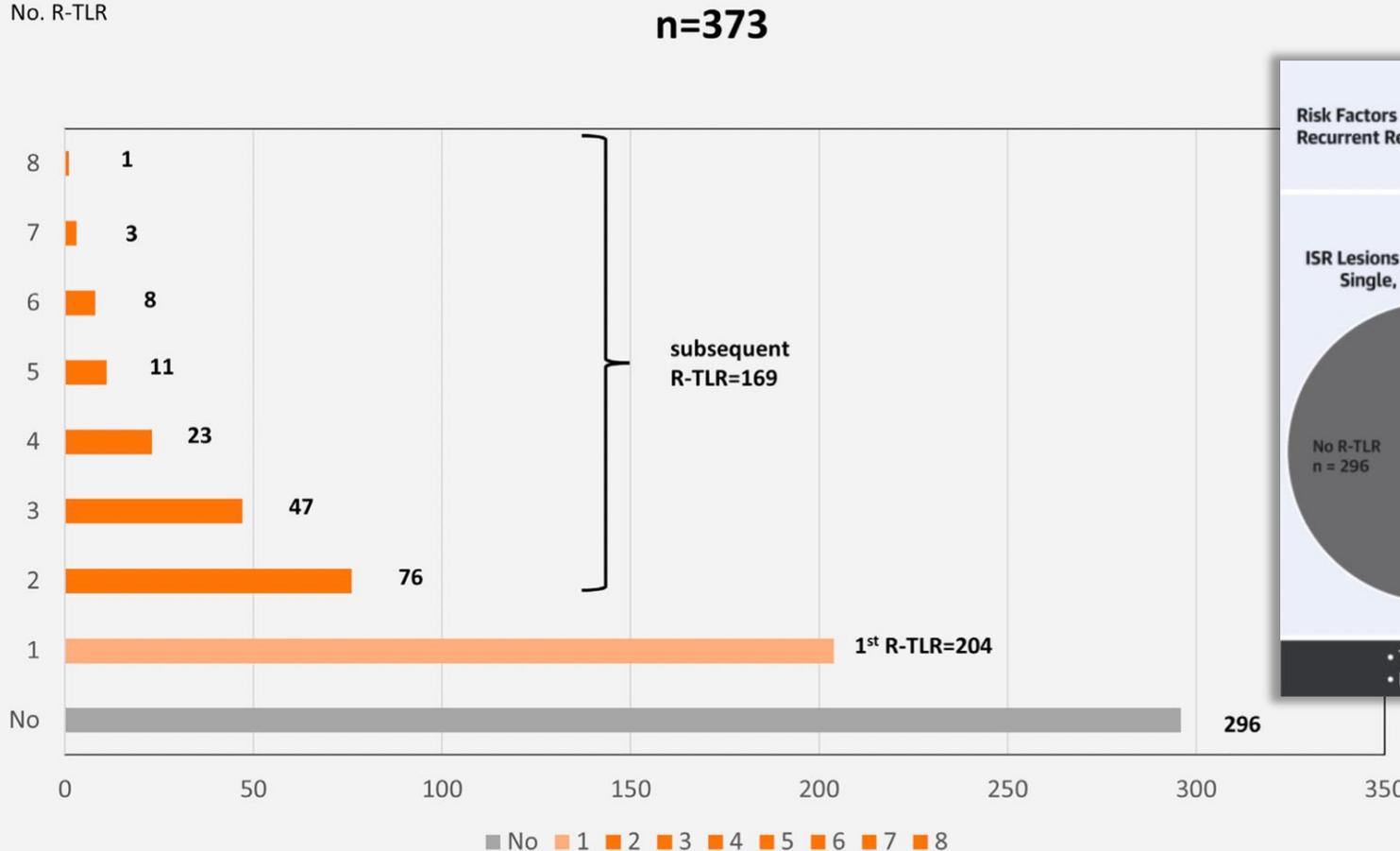


RIS & traitement

ISARE DESIRE 3

Coronary artery restenosis treatment with plain balloon, drug-coated balloon, or drug-eluting stent: 10-year outcomes of the ISAR-DESIRE 3 trial

Number of repeat target lesion revascularizations (R-TLR) n=373



RIS & traitement

**In-stent restenosis characteristics and repeat stenting
underexpansion: insights from optical coherence tomography**

Résultat post angioplastie

143 lésions avec resténose intrastent

Guidage OCT systématique pré et post

Rétrospective, 2 centres

**Sous expansion post angioplastie =
stent expansion < 70% ou MSA < 4.5mm²**

RIS & traitement

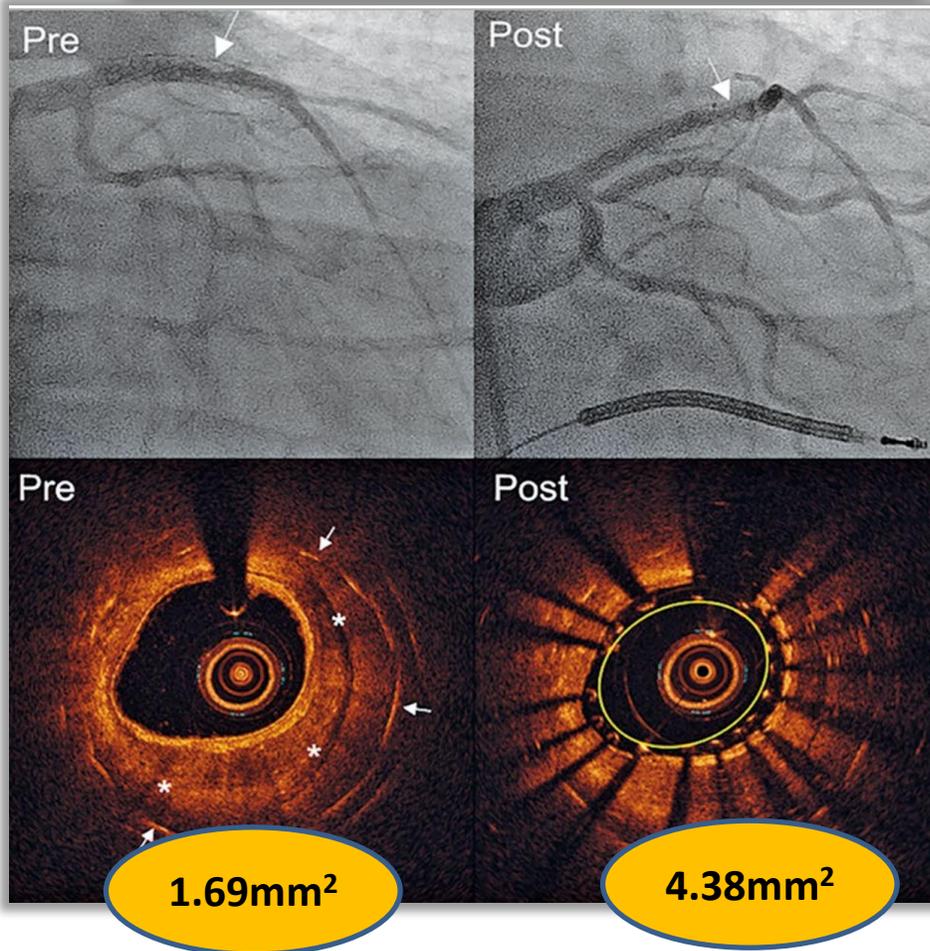
In-stent restenosis characteristics and repeat stenting underexpansion: insights from optical coherence tomography

Résultat post angioplastie

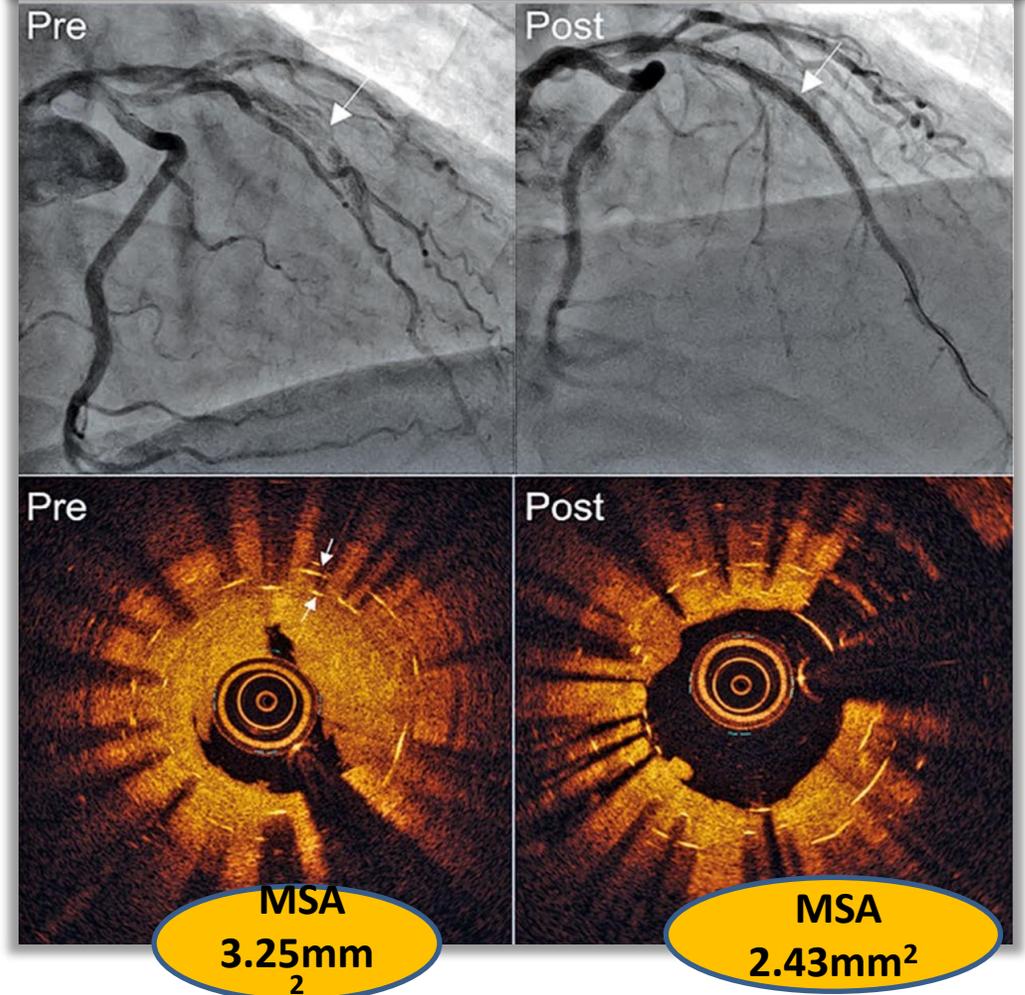
		New stent underexpansion		p-value
		Yes (n=33)	No (n=110)	
Restenotic stent type	Bare metal stent	5 (15.2)	13 (11.8)	0.88
	First-generation drug-eluting stent	10 (30.3)	34 (30.9)	
	Second-generation drug-eluting stent	18 (54.5)	63 (57.3)	
Predilatation		28 (84.8)	87 (79.1)	0.62
Non-compliant balloon		8 (24.2)	17 (15.5)	0.24
Scoring balloon		14 (42.4)	45 (40.9)	0.88
Maximum predilatation pressure, atm		15 (12-19)	14 (12-18)	0.70
Mean new stent diameter, mm		2.75 (2.50-3.00)	3.00 (2.75-3.50)	0.001
Total new stent length, mm		23.0 (16.5-38.0)	22.0 (15.0-33.0)	0.64
Maximum post-dilation balloon diameter, mm		3.00 (2.75-3.38)	3.25 (3.00-3.50)	0.009
Maximum post-dilation pressure, atm		18 (14-20)	20 (16-20)	0.34
Balloon-to-artery ratio*		1.18 (1.04-1.42)	1.30 (1.09-1.44)	0.22

RIS & traitement

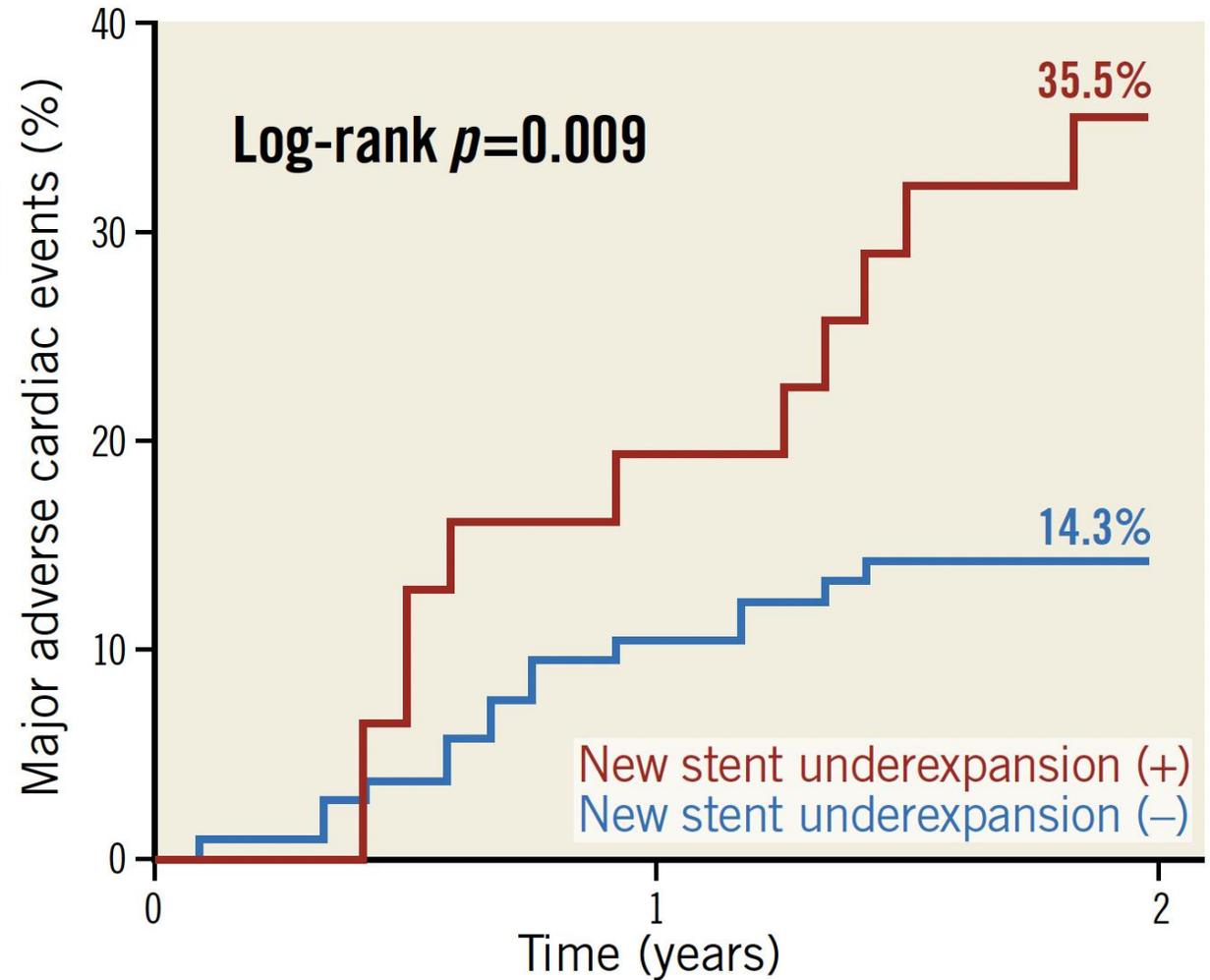
Résultat post angioplastie



In-stent restenosis characteristics and repeat stenting underexpansion: insights from optical coherence tomography

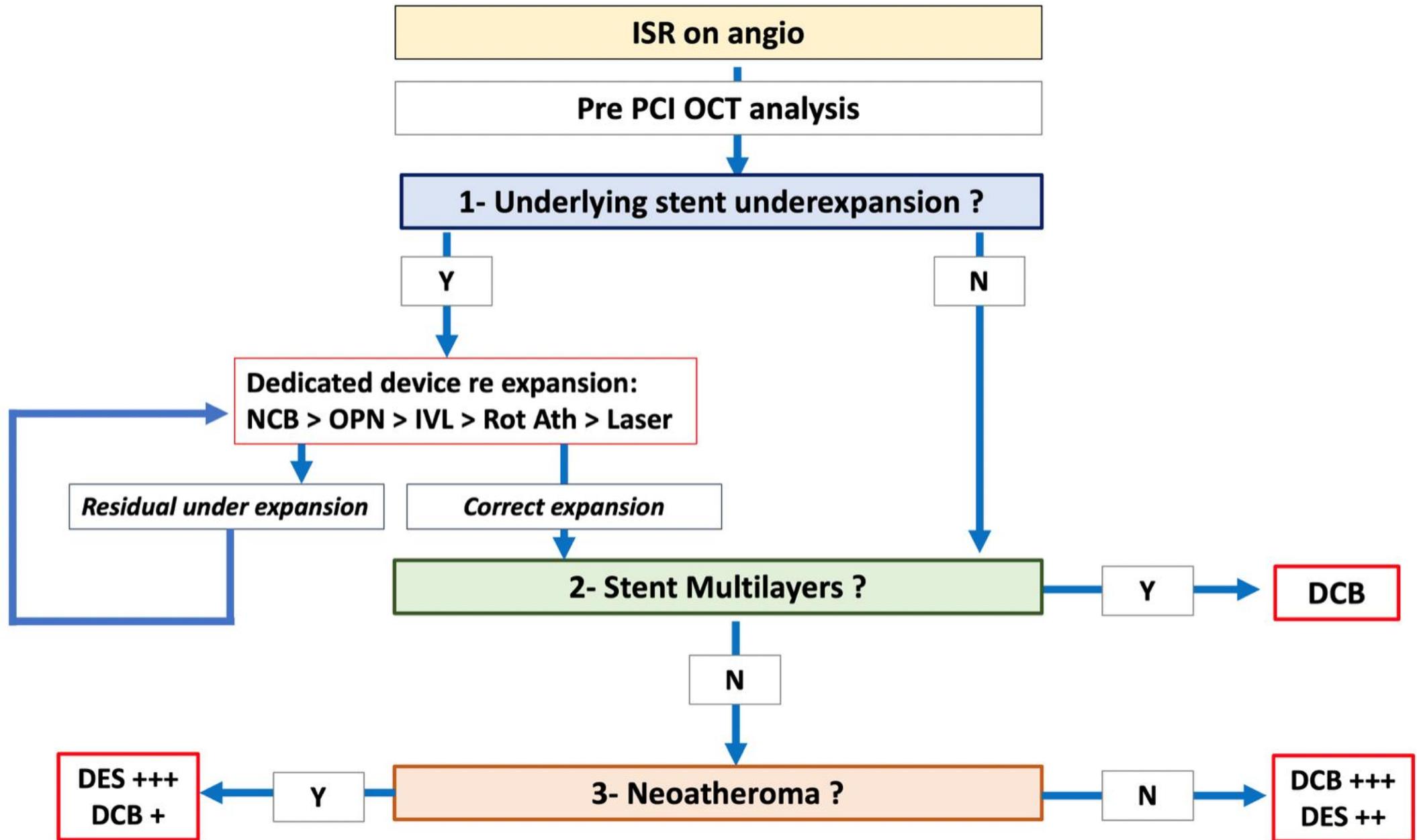


Résultat post angioplastie



Number at risk

New stent underexpansion (+)	110	98	89
New stent underexpansion (-)	33	21	19



1. Define

Identify the culprit ISR lesion



Assess lesion length & severity using orthogonal projections



Use IVI to define ISR



2. Prepare

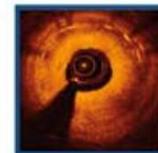
Routine predilatation of all lesions



Use high pressure, cutting or scoring balloons



Address all mechanical factors



3. Treat

DES ISR: DES or DCB



BMS ISR: DCB or DES



Assess PCI result using IVI



Imagerie endocoronaire

Thrombose de stent

Thrombose de stent

54 576 angioplasties



- à 1 an (en baisse)
- Hospitalières (stable)



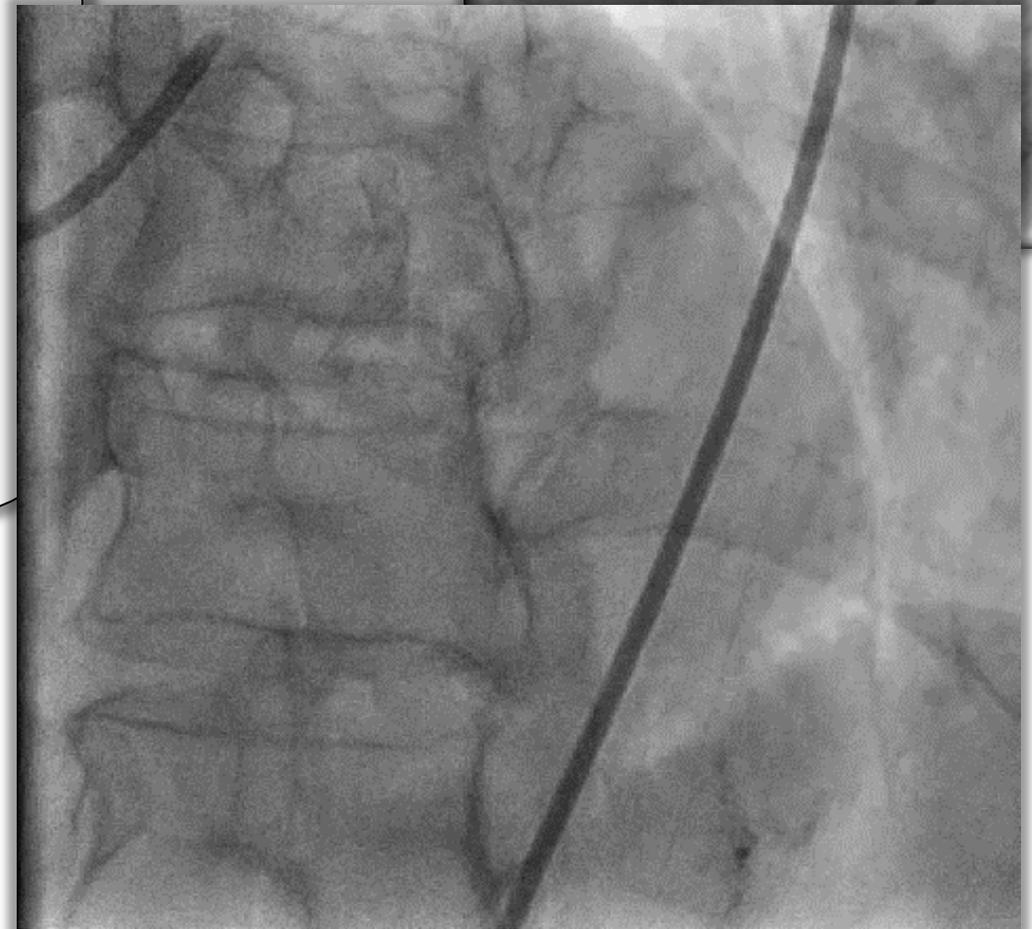
Courtesy G.RANGE

Thrombose de stent

Patiente de 69 ans

**ATCD ATL IVA et Cdte en 2021
Sous Kardegic[®] 75mg**

**ACR avec SCA ST+ antérieur
No flow 3min**



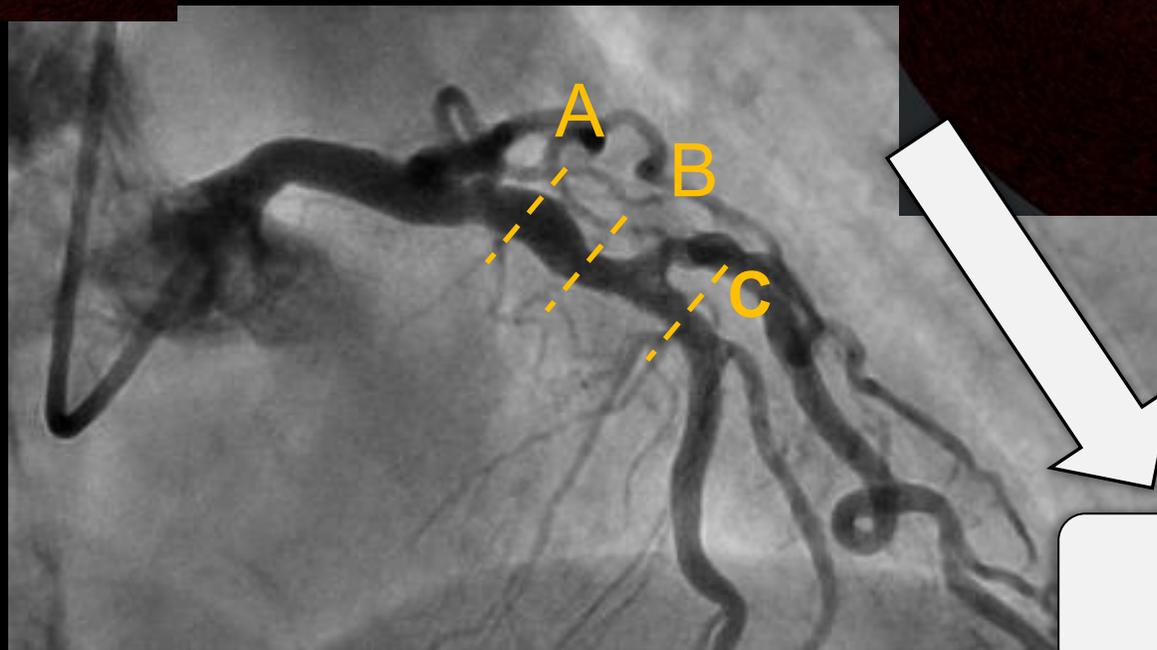
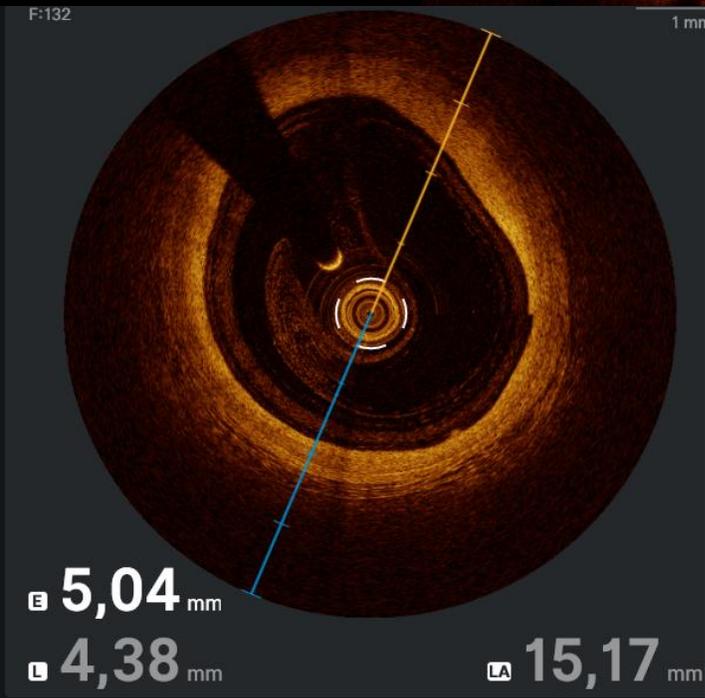
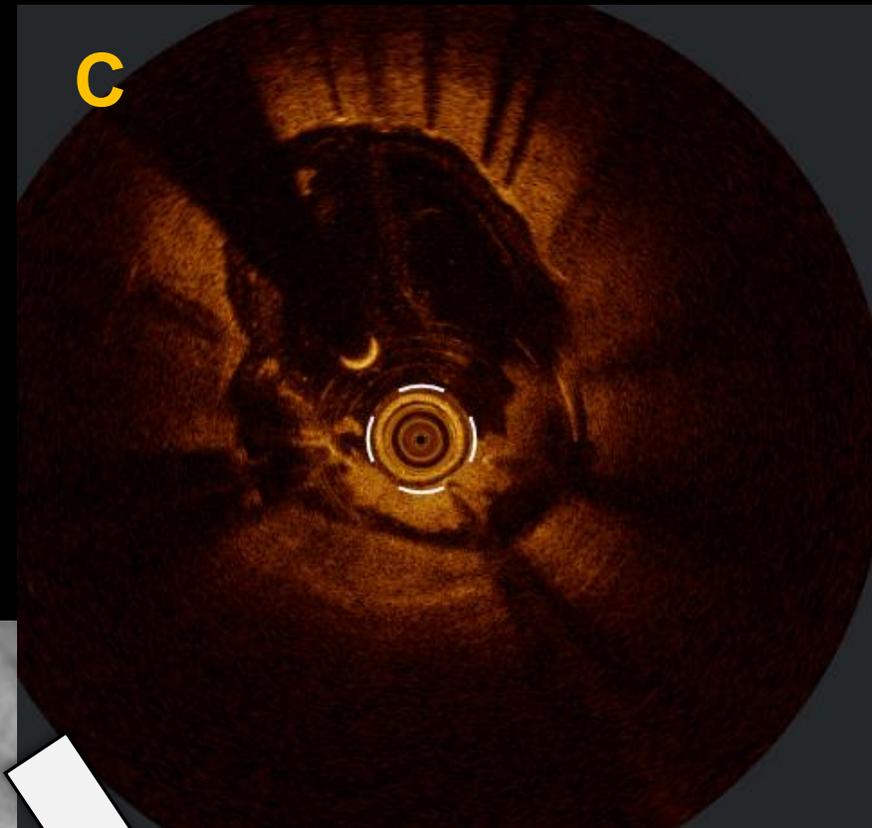
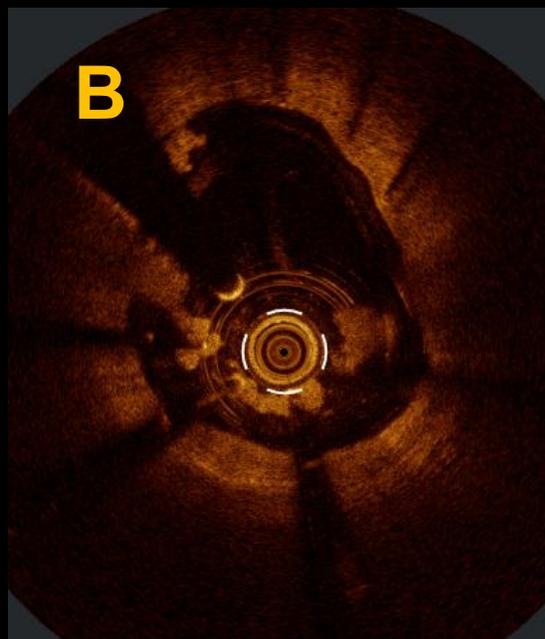
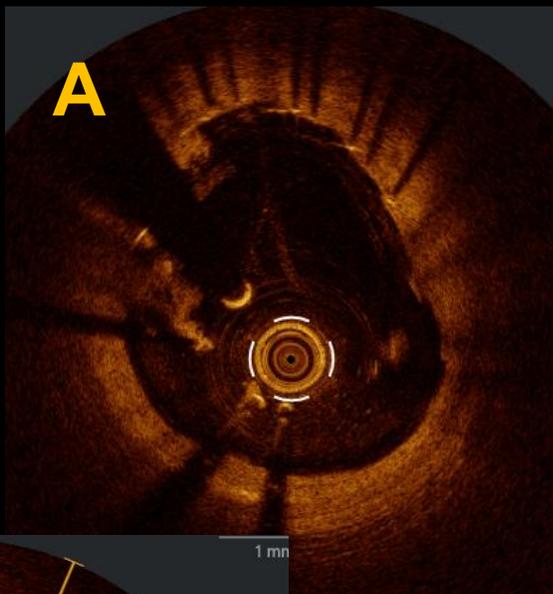
Thrombose de stent

Thrombo-aspiration
Contrôle à J4



Quelle cause à la
thrombose? CAT?

Contrôle à J5



Post-dilatation

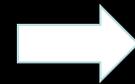
ACS with ST+ coronarography in acute phase (<12h) due to stent thrombosis

(all types of stents, acute;subacute;late and very late)



Optimal thrombectomie

(mechanical and/or médics : thrombo-aspiration, anti GpIIb-IIIa...)



TIMI 3 flow obtained

Consent patient

OCT faisable

*If NO at of 3 items :
No enrollment OCT, registry*

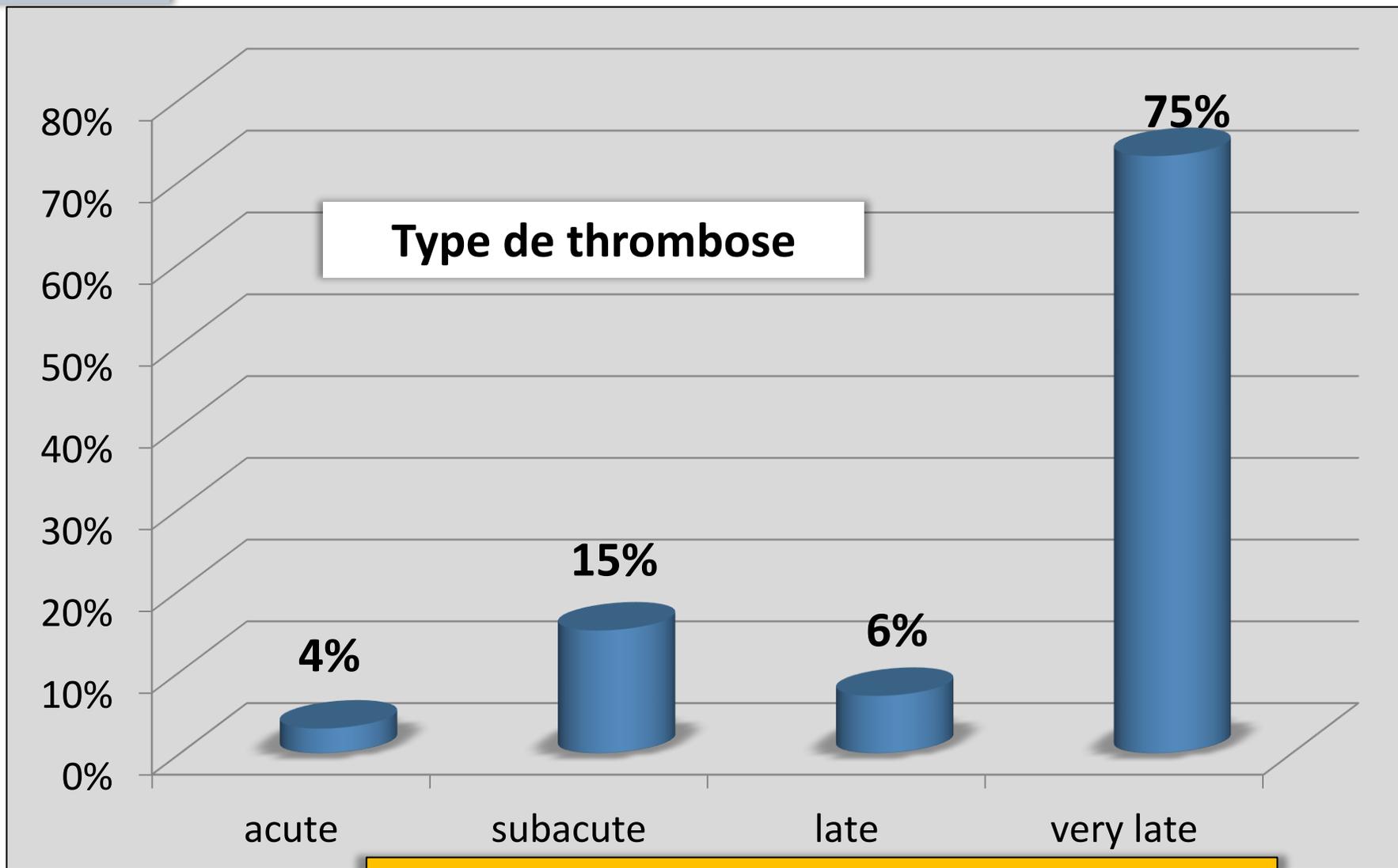


YES



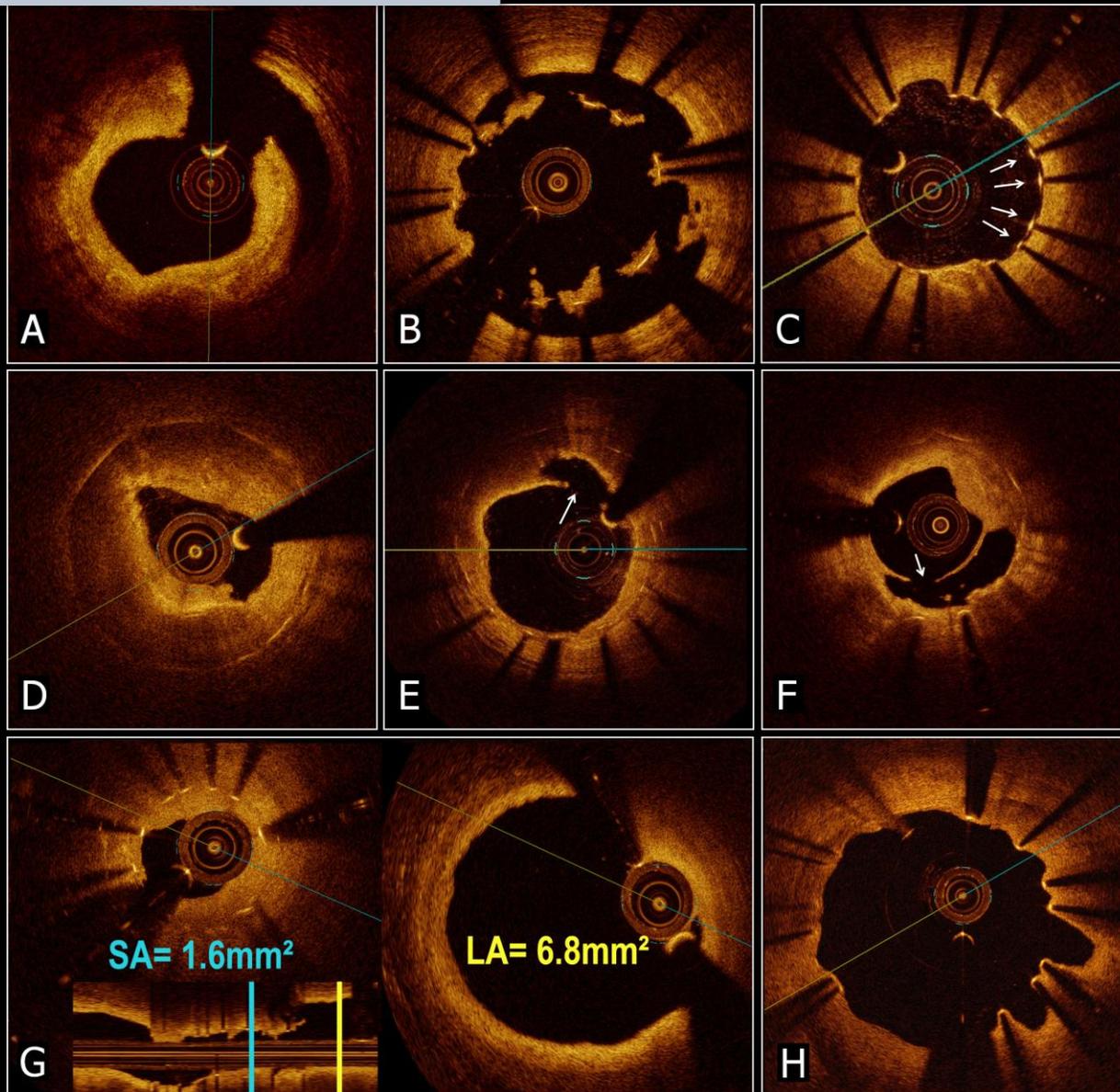
**Note diagnose hypothesis and management before OCT
Immediate OCT or defered (MIMI, D1-D7) decided by the operator
Treatmed guided by OCT**

Analyse 120 patients



Délai moyen thrombose 4.3 ans

Mecanismes de thrombose (n=120)



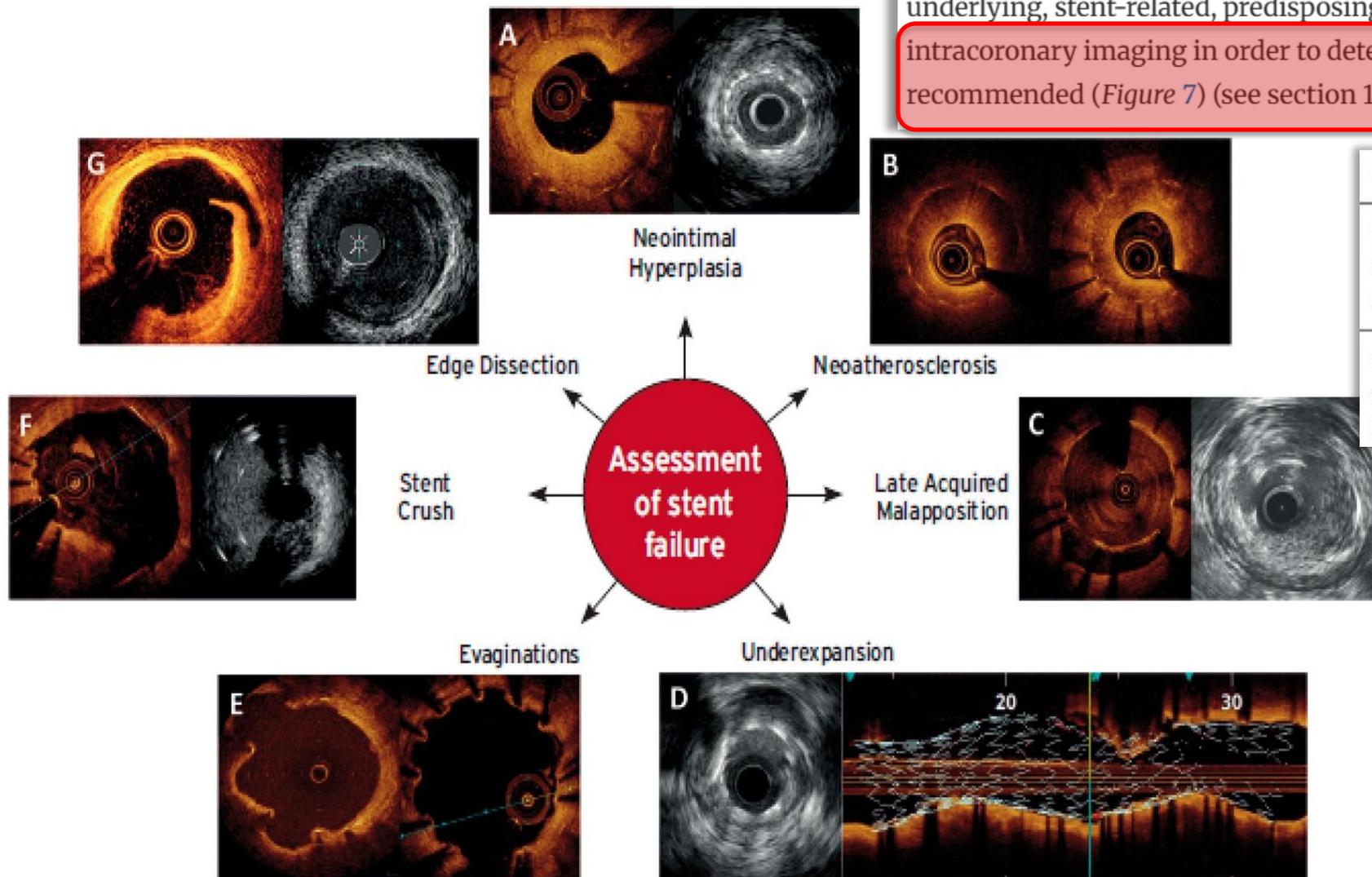
- *Malapposition 34%*
- *Neoatherosclerosis 22%*
- *Sous-expansion 11%*

- *Dilatation au ballon 37%*
- *Traitement médical 32%*
- *Stenting 31%*

OCT influence le
traitement dans
55% des cas

Thrombose de stent

Intracoronary imaging for the assessment of stent failure



underlying, stent-related, predisposing mechanical problems.^{386,387} Liberal use of intracoronary imaging in order to detect and modify underlying mechanical factors is recommended (Figure 7) (see section 16.2).

Recommendations	Class ^a	Level ^b
IVUS or OCT should be considered in selected patients to optimize stent implantation. ^{603,612,651–653}	IIa	B
IVUS should be considered to optimize treatment of unprotected left main lesions. ³⁵	IIa	B

Imagerie & complication stenting

Les limites

Attendre disparition thrombus en OCT

Difficultés de franchissement

Plusieurs causes présentes

Conclusions

Apport de l'imagerie endocoronaire

- Compréhension
- Adapter le traitement
- Evaluer le résultat