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Montevideo, URUGUAY

CardioSUC 2025 41º Congreso Uruguayo de Cardiología
El paciente en el corazón de cada decisión

Imagen intravascular como guía de PCI de TCI

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2025 ACC/AHA/ACEP/NAEMSP/SCAI Guideline for the Management of Patients With Acute Coronary Syndromes

A Report of the American College of Cardiology/American Heart Association Joint Committee on Clinical Practice Guidelines

Recommendation for Use of Intracoronary Imaging
Referenced studies that support recommendation are summarized in the Evidence Table.

COR	LOE	RECOMMENDATION
1	A	1. In patients with ACS undergoing coronary stent implantation in left main artery or in complex lesions, intracoronary imaging with intravascular ultrasound (IVUS) or optical coherence tomography (OCT) is recommended for procedural guidance to reduce ischemic events.*[1-11]

*Adapted from the "2021 ACC/AHA/SCAI Guideline for Coronary Artery Revascularization."[12]

ESC European Society of Cardiology

European Heart Journal (2024) **00**, 1–123
https://doi.org/10.1093/eurheartj/ehae177

ESC GUIDELINES

2024 ESC Guidelines for the management of chronic coronary syndromes

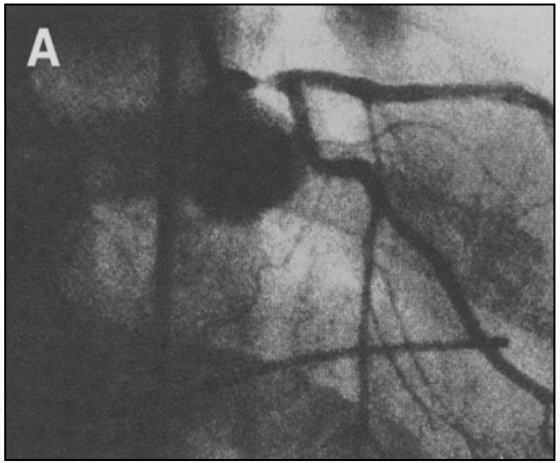
Developed by the task force for the management of chronic coronary syndromes of the European Society of Cardiology (ESC)

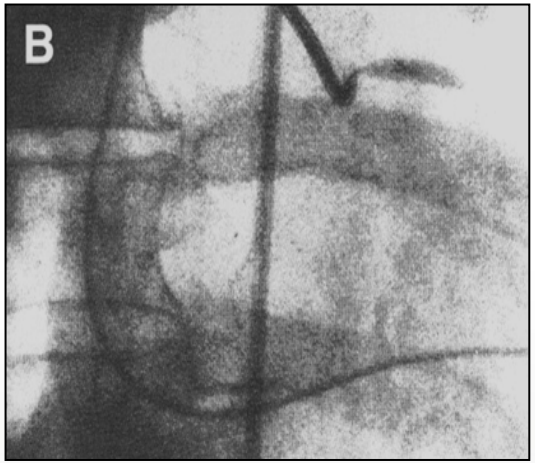
Endorsed by the European Association for Cardio-Thoracic Surgery (EACTS)

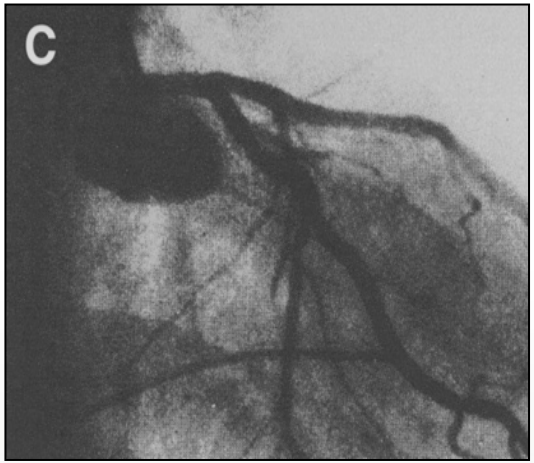
Assessment of procedural risks and post-procedural outcomes		
In patients with complex CAD in whom revascularization is being considered, it is recommended to assess procedural risks and post-procedural outcomes to guide shared clinical decision-making.	I	C
Calculation of the STS score is recommended to estimate in-hospital morbidity and 30-day mortality after CABG.[777,862–864]	I	B
In patients with multivessel obstructive CAD, calculation of the SYNTAX score is recommended to assess the anatomical complexity of disease.[786,865]	I	B
Intracoronary imaging guidance by IVUS or OCT is recommended when performing PCI on anatomically complex lesions, in particular left main stem, true bifurcations, and long lesions.[866,337,810,840,841]	I	A

1977

First PCI of Left Main in The World.







"Third PCI patient ever treated. Forty-three year old man with severe angina pectoris since September, 1977 First angiogram (November 11) revealed severe stenosis of the main L.C.A. . ."

Gruntzig A. Lancet 1978;1:263

Importance reminder:

LM disease occurs in 5-7% of patients undergoing coronarography:

LM supplies 84% (or 100%) of blood to the LV

Medical treatment of ULMCA =

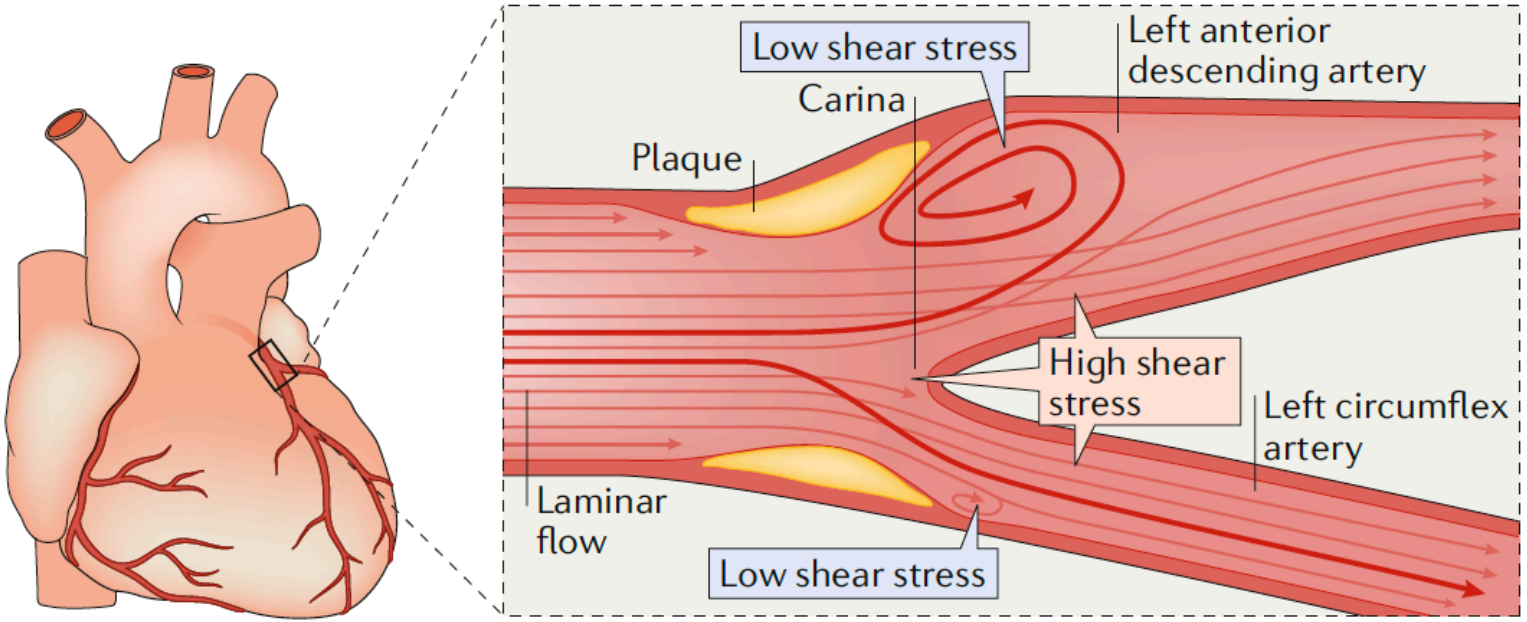
3-year mortality of 50%

Taylor H, Deumite N, Chaitman B, Davis K, Killip J, Rogers W. Asymptomatic left main coronary artery disease in the Coronary Artery Surgery Study (CASS) registry. Circulation. 1989;79:1171–1179.

Stone P, Goldschlager N. Left main coronary artery disease: review and appraisal. *Cardiovasc Med*. 1979;4:165 – 177.

Sianos G, Morel MA, A.P. K, Morice MC, Colombo A, Dawkins K, van den Brand M, Dyck NV, Russell ME, Mohr FW, Serruys PW. (2005) The SYNTAX score: an angiographic tool grading the complexity of coronary artery disease. EuroIntervention. 2005;1:219-27. The birth of the SYNTAX Score.

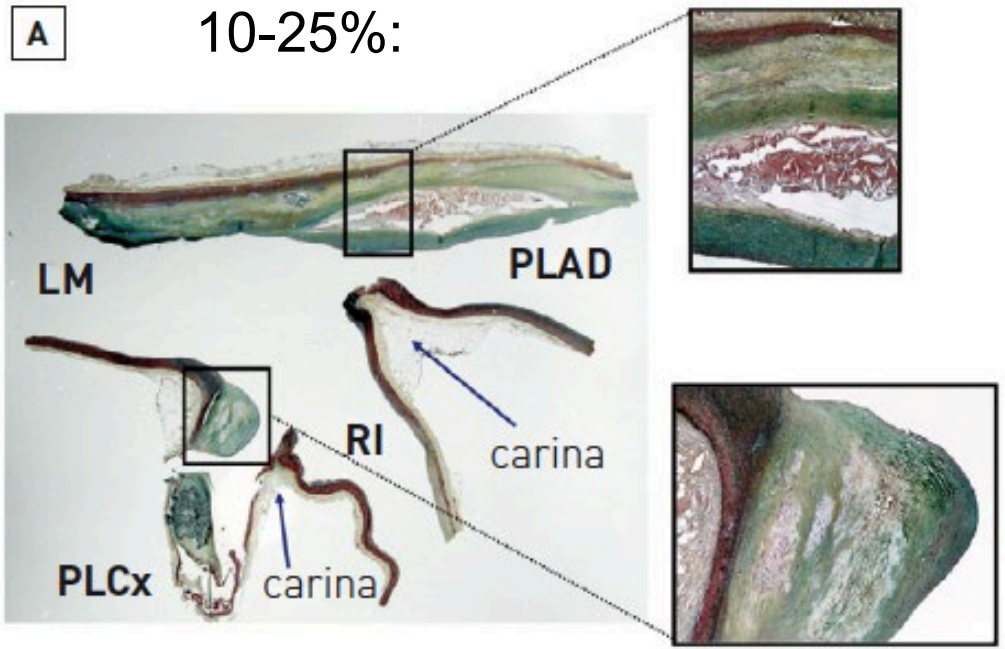
Anatomy and pathophysiology

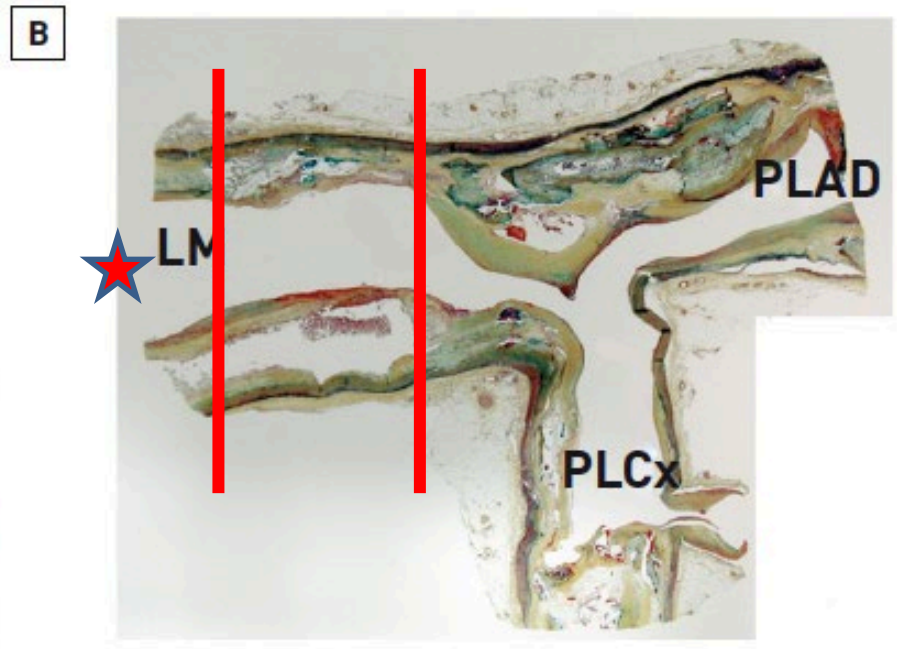


Length: 10.8±5.2 mm (range 2 to 23 mm). Diameter: 4.9±0.8 mm,
Angle of the terminal division: 86.7 ± 28.8° (range 40° to 165°)

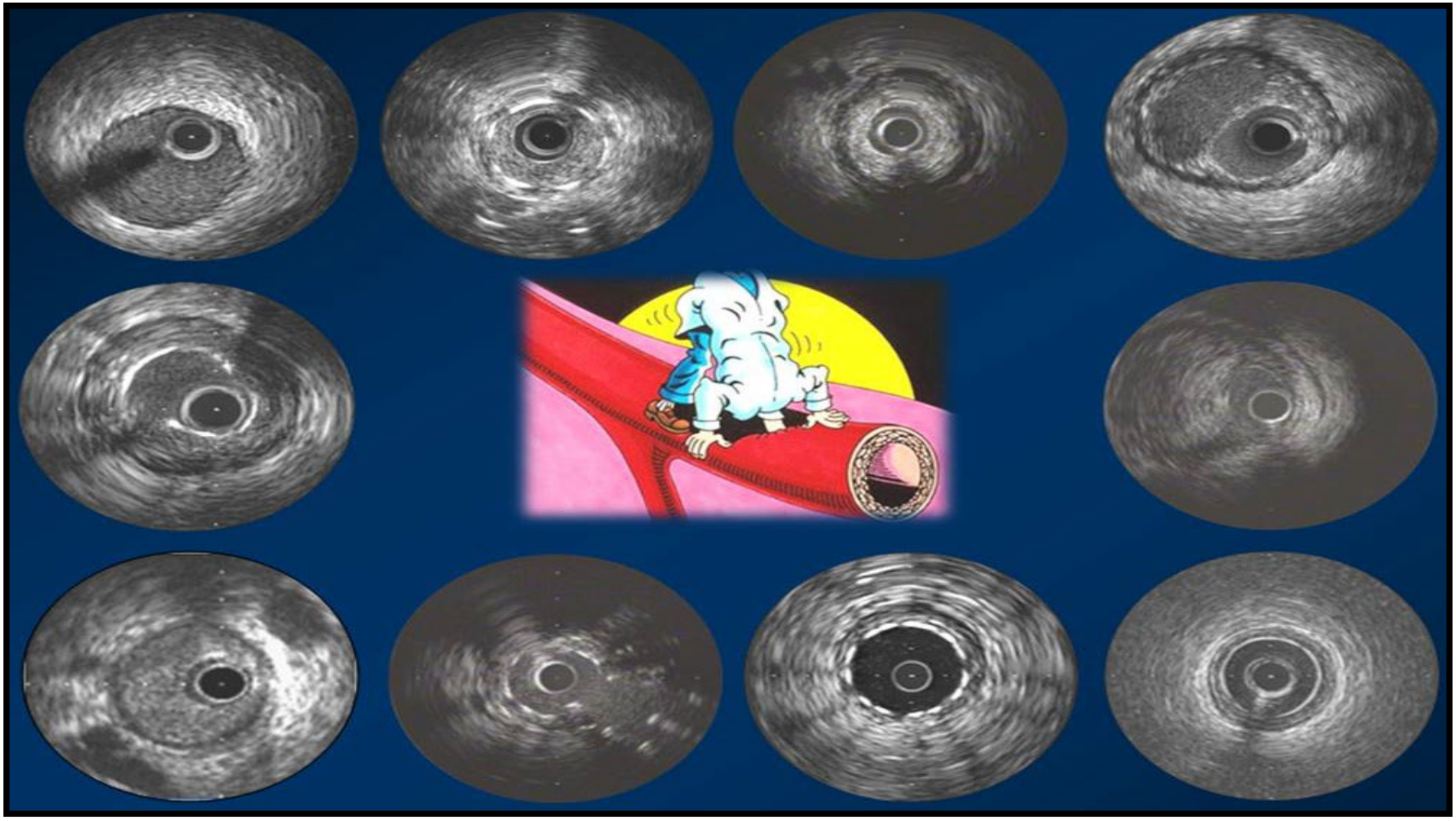
Collet C, Capodanno D, Onuma Y, Banning A, Stone GW, Taggart DP, Sabik J, Serruys PW. Left main coronary artery disease: pathophysiology, diagnosis, and treatment. Nat Rev Cardiol. 2018 Jun;15(6):321-331.

Anatomy and pathophysiology



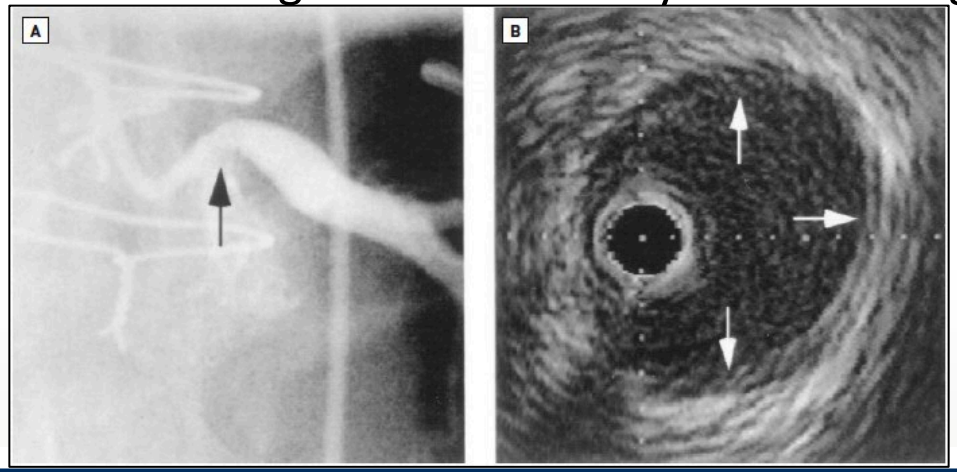


Fajadet J, Chieffo A. Current management of left main coronary artery disease. Eur Heart J. 2012;33.



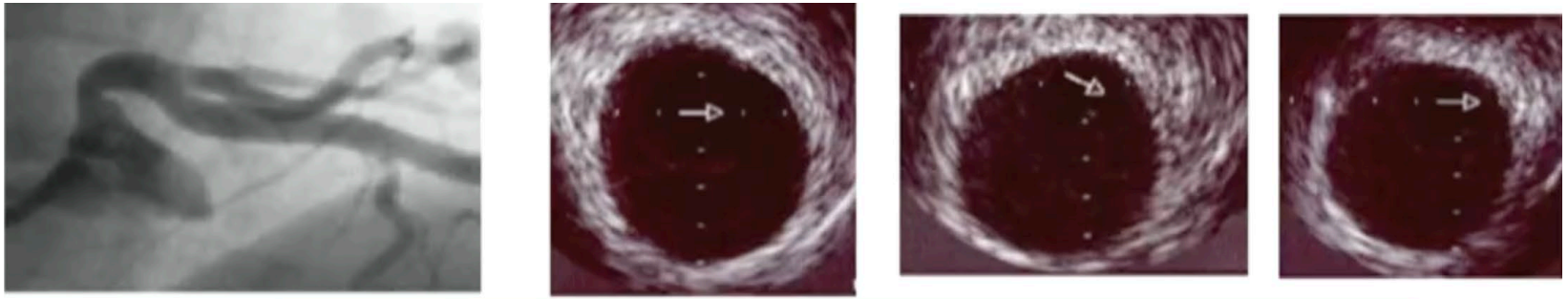
IVUS in LM PCI

LM is the vessel with the greatest variability between angio and IVUS.

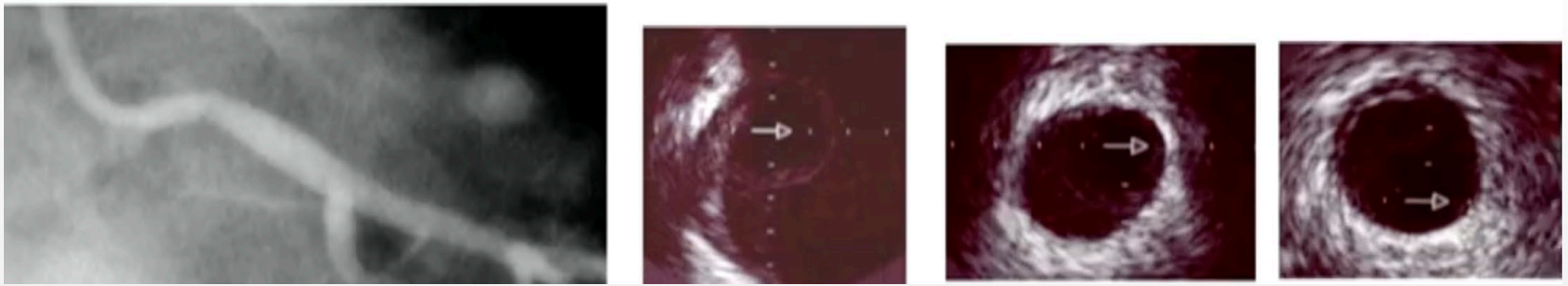


Recommendation for Intravascular Ultrasound to Assess Lesion Severity
Referenced studies that support the recommendation are summarized in Online Data Supplement 6.

COR	LOE	RECOMMENDATION
2a	B-NR	1. In patients with intermediate stenosis of the left main artery, intravascular ultrasound (IVUS) is reasonable to help define lesion severity (1-5).

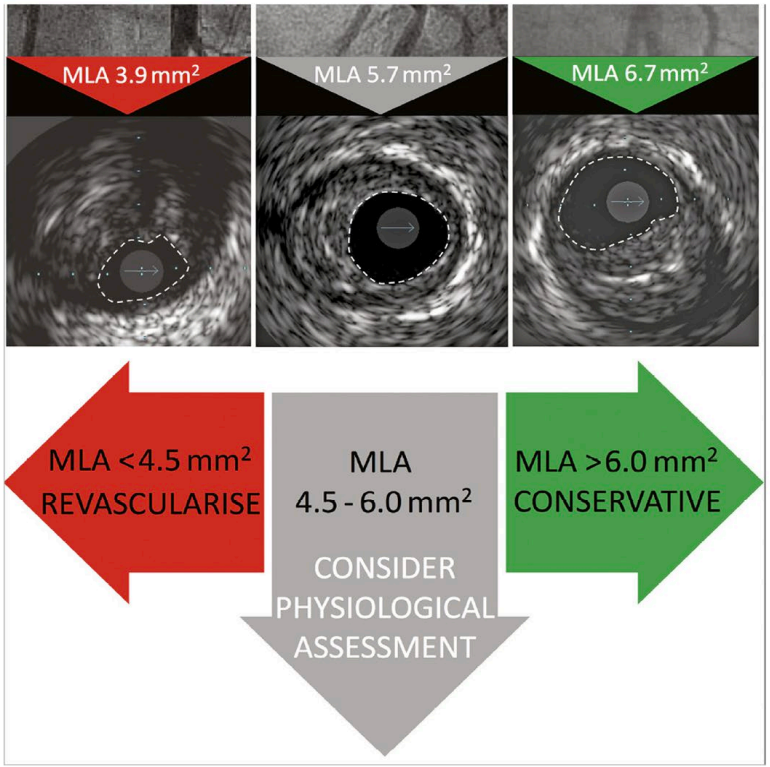


IVUS = No disease (angio artifacts) = **No PCI**



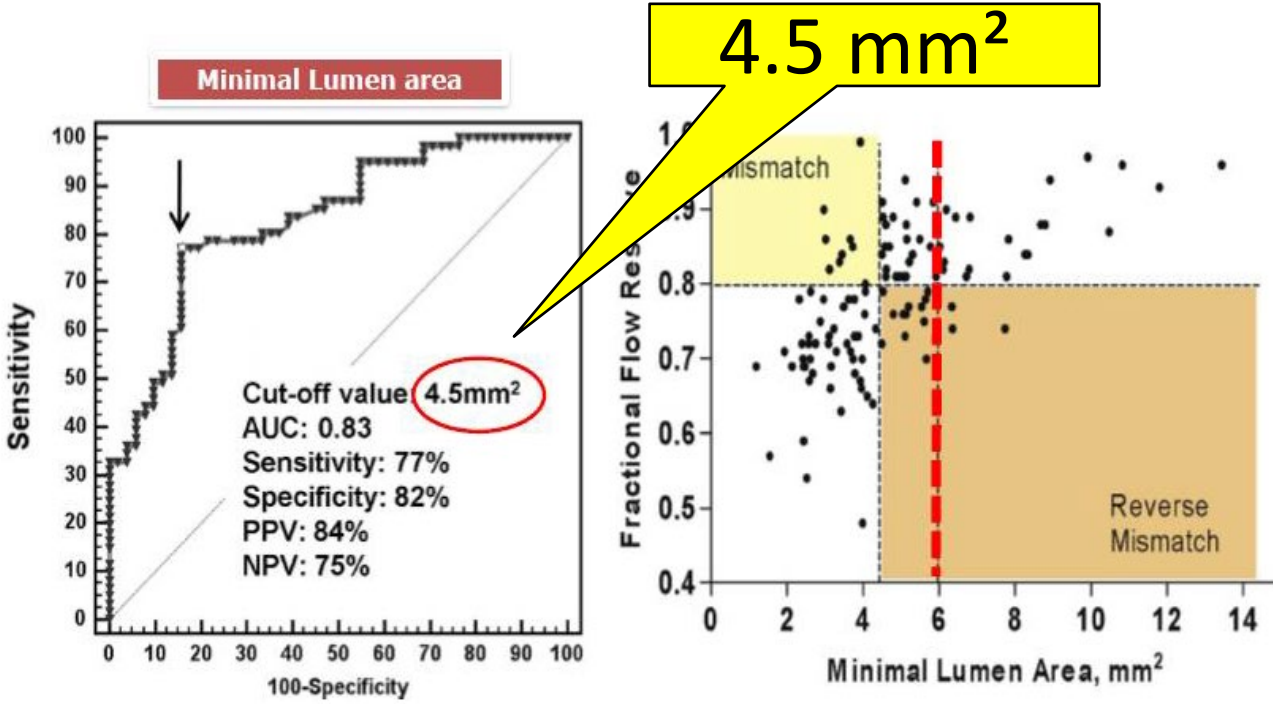
IVUS in LM PCI: evaluation

- Johnson TW, Räber L, Di Mario C, Bourantas CV, Jia H, Mattesini A, Gonzalo N, de la Torre Hernandez JM, Prati F, Koskinas KC, Joner M, Radu MD, Erlinge D, Regar E, Kunadian V, Maehara A, Byrne RA, Capodanno D, Akasaka T, Wijns W, Mintz GS, Guagliumi G. Clinical use of intracoronary imaging. Part 2: acute coronary syndromes, ambiguous coronary angiography findings, and guiding interventional decision-making: an expert consensus document of the European Association of Percutaneous Cardiovascular Interventions. EuroIntervention. 2019 Aug 29;15(5):434-451. doi: 10.4244/EIJY19M06_02. PMID: 31258132.



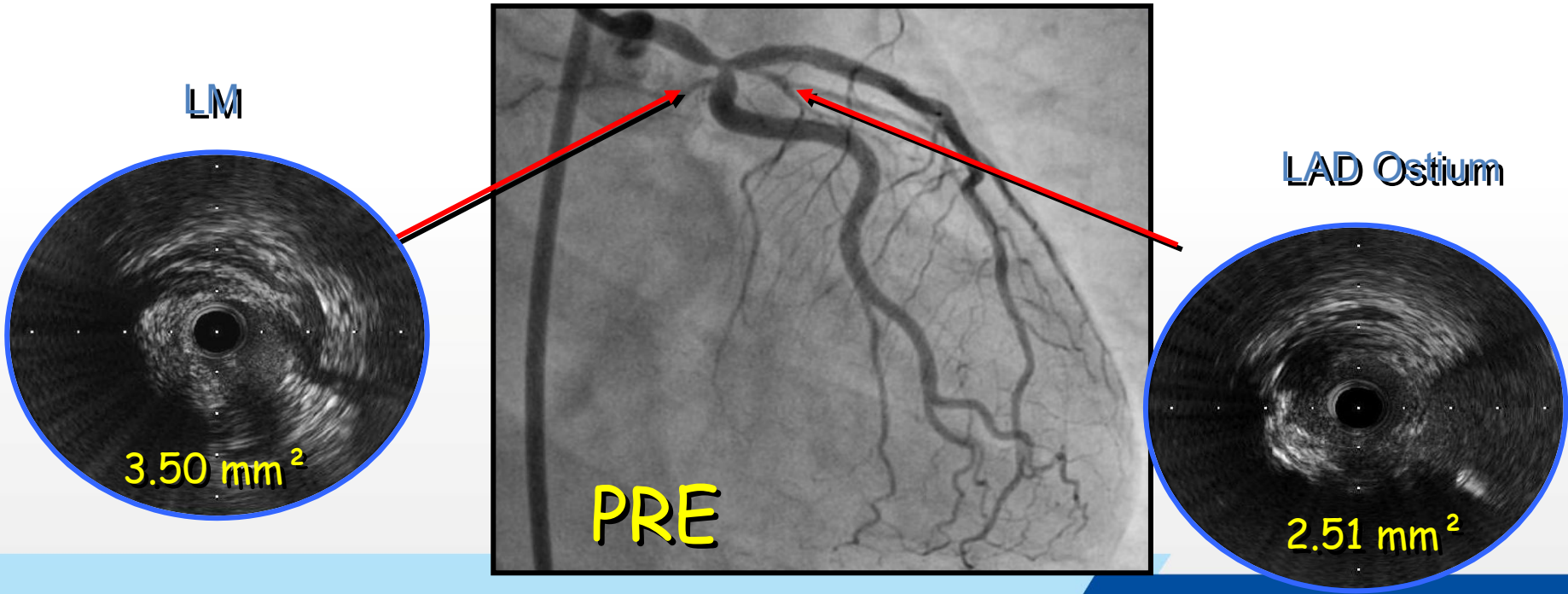
IVUS-Derived Minimal Lumen Area Criteria for Functionally Significant Left Main Coronary Artery Stenosis

112 patients with isolated ostial and shaft intermediate LMCA stenosis (angiographic diameter stenosis of 30% to 80%) who underwent IVUS and FFR measurement.



DIAGNÓSTICO

2) Evaluación de lesiones ambiguas y morfologías inusuales



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Evidence: PCI vs CABG for LM

Study	Study population	Primary endpoint	Follow-up	Findings
PRECOMBAT (non-inferiority)[814]	600 patients with newly diagnosed LMCAD who had stable angina, unstable angina, silent ischaemia, or non-ST-segment elevation MI	All-cause death, MI, stroke, or ischaemia-driven target vessel revascularization	2 years	1-year follow-up: 8.7% and 6.7% primary endpoints for PCI and CABG, respectively, absolute risk difference 2% (95% CI, –1.6% to 5.6%), $P = .01$ for non-inferiority 2-year follow-up: 12.2% and 8.1% primary endpoints for PCI and CABG, respectively, HR 1.50 (95% CI, 0.90–2.52), $P = .12$
PRECOMBAT (extended follow-up)[815]			5 years	17.5% and 14.3% primary endpoints for PCI and CABG, respectively, HR 1.27 (95% CI, 0.84–1.90), $P = .26$
PRECOMBAT (extended follow-up)[816]			11.3 years (median)	29.8% and 24.7% primary endpoints for PCI and CABG, respectively, HR 1.25 (95% CI, 0.93–1.69)
SYNTAX[817]	1800 patients with *de novo* three-vessel ($n = 1095$) and LMCAD ($n = 795$)	All-cause death, stroke, MI, and repeat revascularization	1 year	For the LMCAD group: 15.8% and 13.7% primary endpoints for PCI and CABG, respectively; $P = .44$
SYNTAX[818]			3 years	For the LMCAD group: 26.8% and 22.3%, primary endpoints for PCI and CABG, respectively; $P = .20$
SYNTAX[813]			5 years	For the LMCAD group: 36.9% and 31.0% primary endpoints for PCI and CABG, respectively, HR 1.25 (95% CI, 0.93–1.69), $P = .12$
SYNTAX (extended follow-up)[795]		All-cause death	10 years	For the LMCAD group: 27% and 28% primary endpoints for PCI and CABG, respectively, HR 0.92 (95% CI, 0.69–1.22)
NOBLE (non-inferiority hypothesis)[819]	1201 patients with LMCAD who had stable angina pectoris, unstable angina pectoris, or non-ST-segment elevation myocardial infarction	All-cause death, non-procedural MI, any repeat coronary revascularization, or stroke	3.1 years (mean)	28% and 18% primary endpoints for PCI and CABG, HR 1.51 (95% CI, 1.13–2.00), $P = .004$ for superiority
NOBLE (extended follow-up)[820]			4.9 years (median)	28% and 19% primary endpoints for PCI and CABG, HR 1.58 (95% CI, 1.24–2.01), $P < .001$ for superiority
EXCEL (non-inferiority hypothesis)[821]	1905 patients with LMCAD of low or intermediate anatomical complexity (SYNTAX score ≤ 32)	All-cause death, stroke, or MI	3 years (median)	15.4% and 14.7% primary endpoints for PCI and CABG, absolute risk difference 0.7% (upper 97.5% confidence limit: 4%), $P = .02$ for non-inferiority; HR 1.00 (95% CI, 0.79–1.26), $P = .98$ for superiority
EXCEL (extended follow-up)[822]			5 years	22.0% and 19.2% primary endpoints for PCI and CABG, absolute risk difference 2.8% (95% CI, –0.9 to 6.5), $P = .13$; OR 1.19 (95% CI, 0.95–1.50)

Anatomically and clinically based recommendations for revascularization in CCS	Class[a]	Level[b]
Left main disease		
In CCS patients at low surgical risk[c] with significant left main coronary stenosis, CABG:		
• is recommended over medical therapy alone to improve survival;[719]	I	A
• is recommended as the overall preferred revascularization mode over PCI, given the lower risk of spontaneous myocardial infarction and repeat revascularization.[728,730,782]	I	A
In CCS patients with significant left main coronary stenosis of low complexity (SYNTAX score ≤22), in whom PCI can provide equivalent completeness of revascularization to that of CABG, PCI is recommended as an alternative to CABG, given its lower invasiveness and non-inferior survival.[718,728,730,802,813]	I	A
In CCS patients with significant left main coronary stenosis of intermediate complexity (SYNTAX score 23–32), in whom PCI can provide equivalent completeness of revascularization to that of CABG, PCI should be considered, given its lower invasiveness and non-inferior survival.[718,728,730,802,805,809,813,820,822]	IIa	A

Assessment of procedural risks and post-procedural outcomes		
In patients with complex CAD in whom revascularization is being considered, it is recommended to assess procedural risks and post-procedural outcomes to guide shared clinical decision-making.	I	C
Calculation of the STS score is recommended to estimate in-hospital morbidity and 30-day mortality after CABG.[777,862–864]	I	B
In patients with multivessel obstructive CAD, calculation of the SYNTAX score is recommended to assess the anatomical complexity of disease.[786,865]	I	B
Intracoronary imaging guidance by IVUS or OCT is recommended when performing PCI on anatomically complex lesions, in particular left main stem, true bifurcations, and long lesions.[866,337,810,840,841]	I	A

Intracoronary pressure measurement (FFR or iFR) or computation (QFR) :		
• is recommended to guide lesion selection for intervention in patients with multivessel disease;[308,826,866,867]	I	A
• should be considered at the end of the procedure to identify patients at high risk of persistent angina and subsequent clinical events;[828,830,831,868]	IIa	B
• may be considered at the end of the procedure to identify lesions potentially amenable to treatment with additional PCI.[350,829,831]	IIb	B

Impacto del IVUS en la ATC

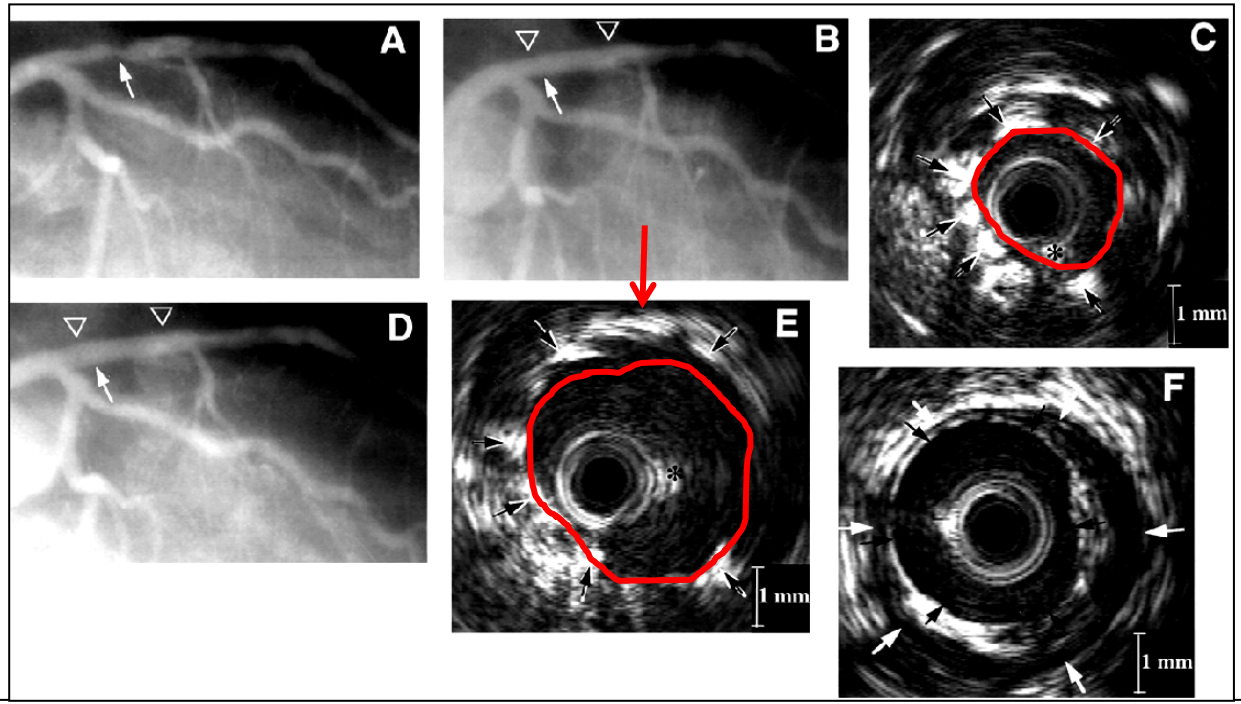
Corrección de los 3 principales mecanismos de falla de la ATC con DES: subexpansión del stent, aposición incompleta de struts en la pared arterial y cobertura incompleta de la placa arteriosclerótica.

- Aumento del diámetro del stent o balón (38%)
- Mayor presión durante la póst dilatación con balón (23%)
- Selección de stents más largos (22%)
- Póst dilatación com balón para corregir subexpansión (13%)
- Póst dilatación com balón para mala aposición de struts (8%)
- Implante de stent adicional (7%)

Witzenbichler et al. Circulation 2014;129:463-70

Intracoronary Stenting Without Anticoagulation Accomplished With Intravascular Ultrasound Guidance

Antonio Colombo, MD; Patrick Hall, MD; Shigeru Nakamura, MD; Yaron Almagor, MD; Luigi Maiello, MD; Giovanni Martini, CCP; Antonio Gaglione, MD; Steven L. Goldberg, MD; Jonathan M. Tobis, MD



Despite this aggressive inflation approach, 40% of the stents with an acceptable angiographic result still required additional dilatation with higher pressures or, less commonly, a dilatation with a larger balloon

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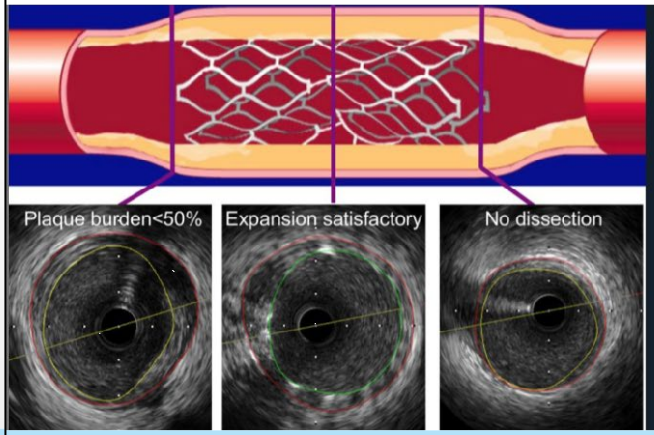
Guía para la correcta implantación de stent coronario

APOSICIÓN. EXPANSIÓN

Cobertura completa de la lesión

Disección. Protrusión de placa. Trombo

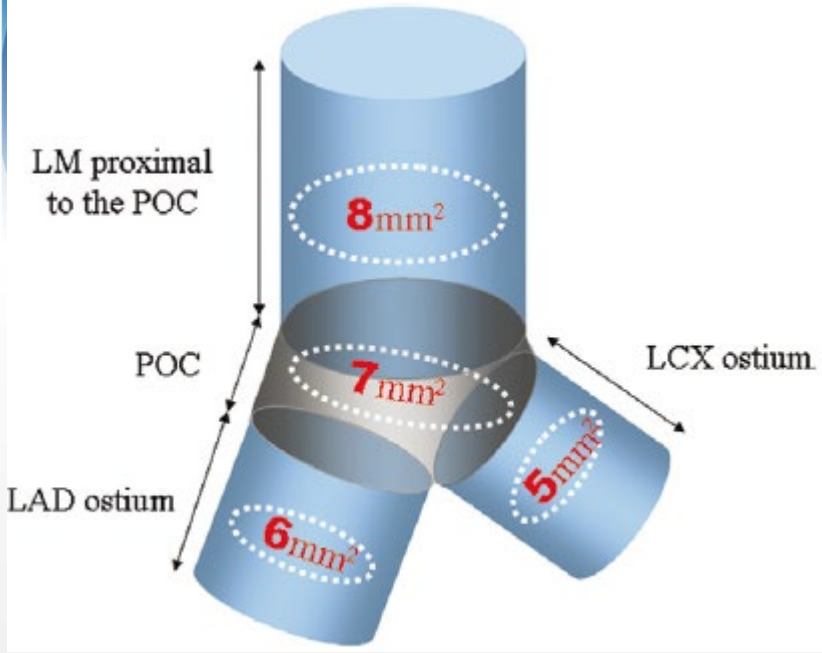
ULTIMATE trial



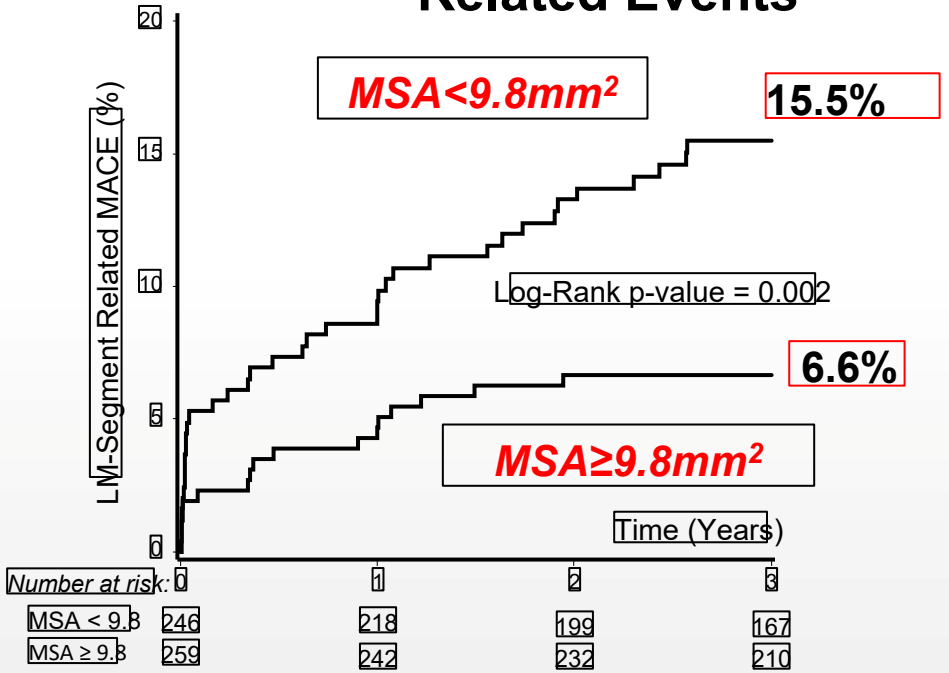
1. Minimal lumen CSA in stented segment >5.0 mm^2, or 90% of distal reference lumen CSA;
2. Plaque burden at the 5-mm proximal or distal to the stent edge <50%;
3. no edge dissection involving media with length >3mm.

Zhang J, et al. J Am Coll Cardiol 2018;Sep 24:[Epub]

IVUS in LM PCI: goals



EXCEL: MSA to Predict LMCA-Related Events



Gary Mintz., CRT 2019

Kang SJ, Ahn JM, Song H, Kim WJ, Lee JY, Park DW, Yun SC, Lee SW, Kim YH, Lee CW, Mintz GS, Park SW, Park SJ. Comprehensive intravascular ultrasound assessment of stent area and its impact on restenosis and adverse cardiac events in 403 patients with unprotected left main disease. *Circ Cardiovasc Interv*. 2011;4:562-9

LM THE BIG IS BETTER

BIGGER IS BETTER
(Donald S Baim) Circulation 1992;86:1827-35)

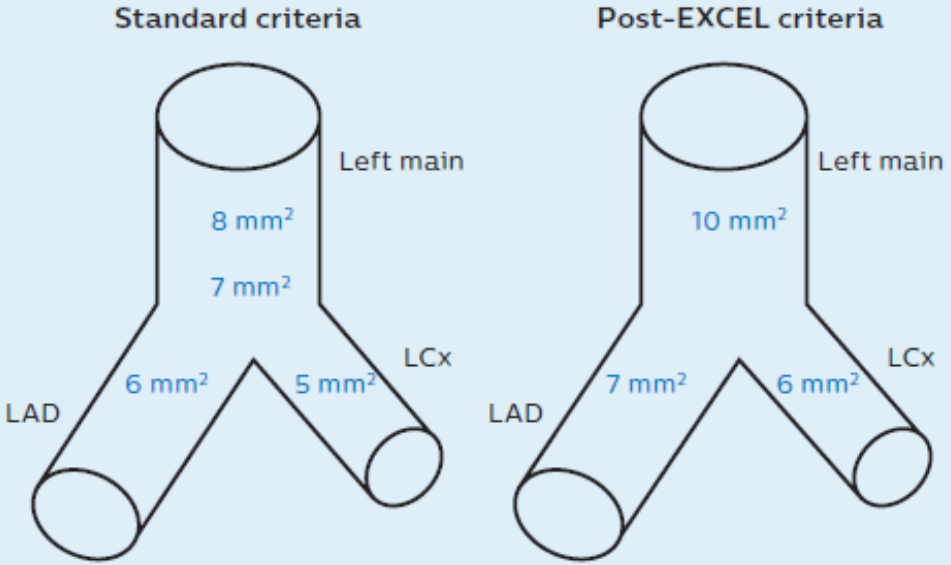
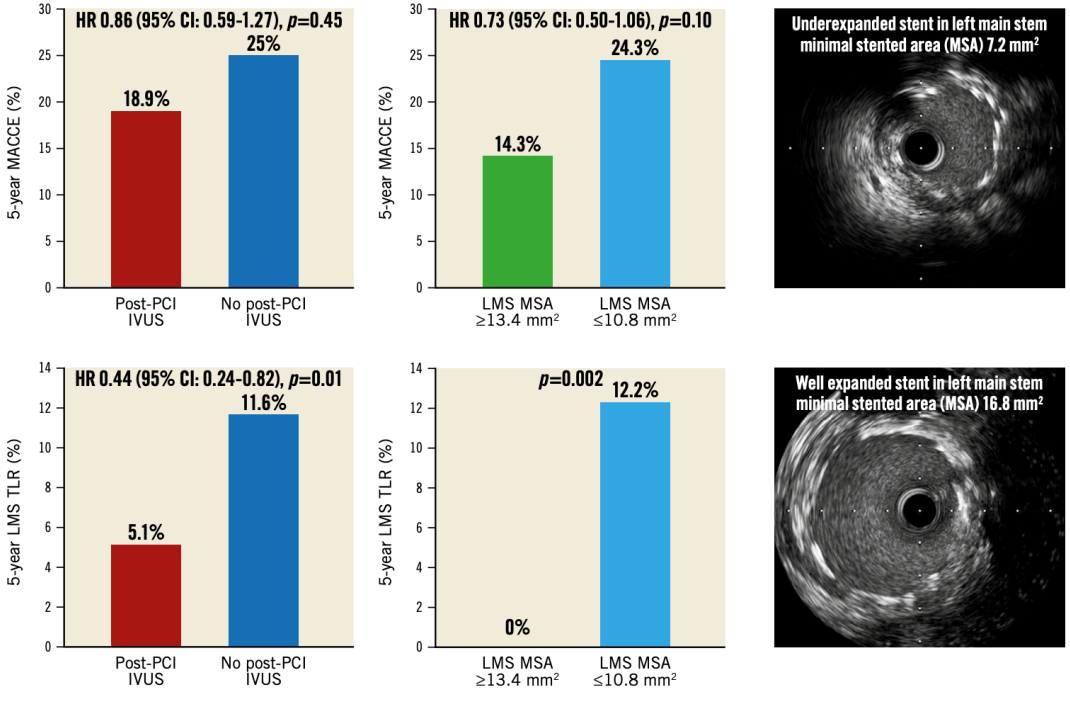


Figure 4: IVUS Criteria For Stent Optimisation in the Treatment of Distal Left Main Bifurcation

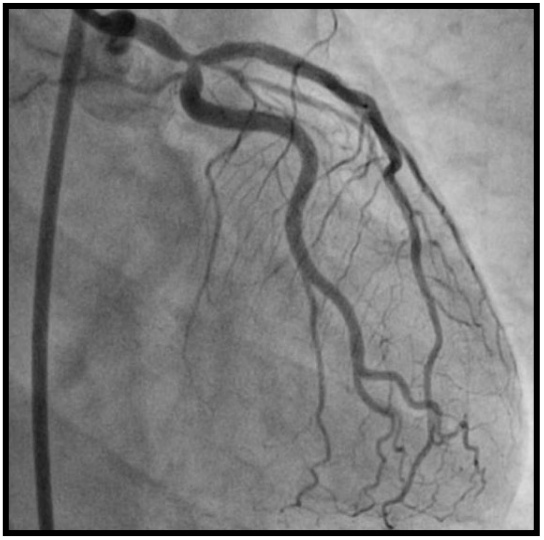
LAD = left anterior descending; LCx = left circumflex.

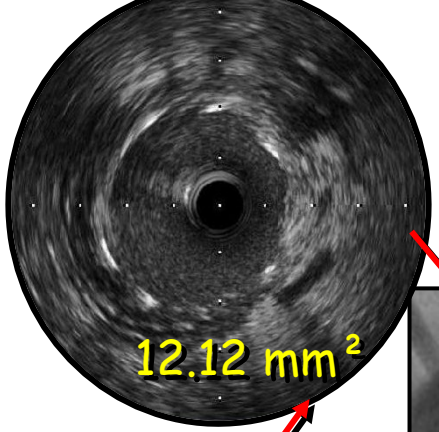
IVUS in LM PCI: NOBLE substudy

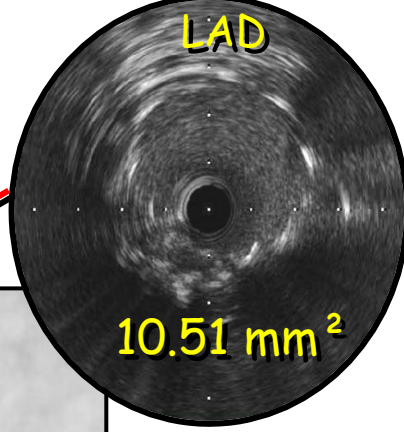


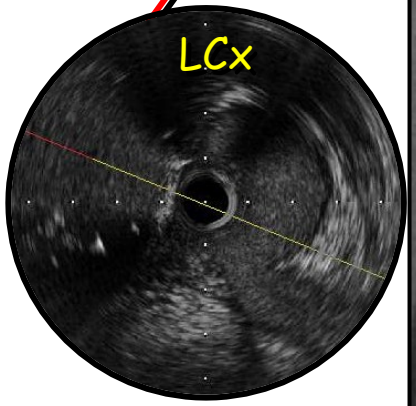
Visual summary. *Rates of MACCE (top) and left main stem target revascularisation (bottom) for patients with and without post-PCI IVUS assessment (left) and lower and upper LMS minimal stented area tertiles (right).*

Ladwiniec A, Walsh SJ, Holm NR, Hanratty CG, Mäkikallio T, Kellerth T, Hildick-Smith D, Mogensen LJH, Hartikainen J, Menown IBA, Erglis A, Eriksen E, Spence MS, Thuesen L, Christiansen EH. Intravascular ultrasound to guide left main stem intervention: a NOBLE trial substudy. EuroIntervention. 2020 Jun 25;16(3):201-209. doi: 10.4244/EIJ-D-19-01003. PMID: 32122821.



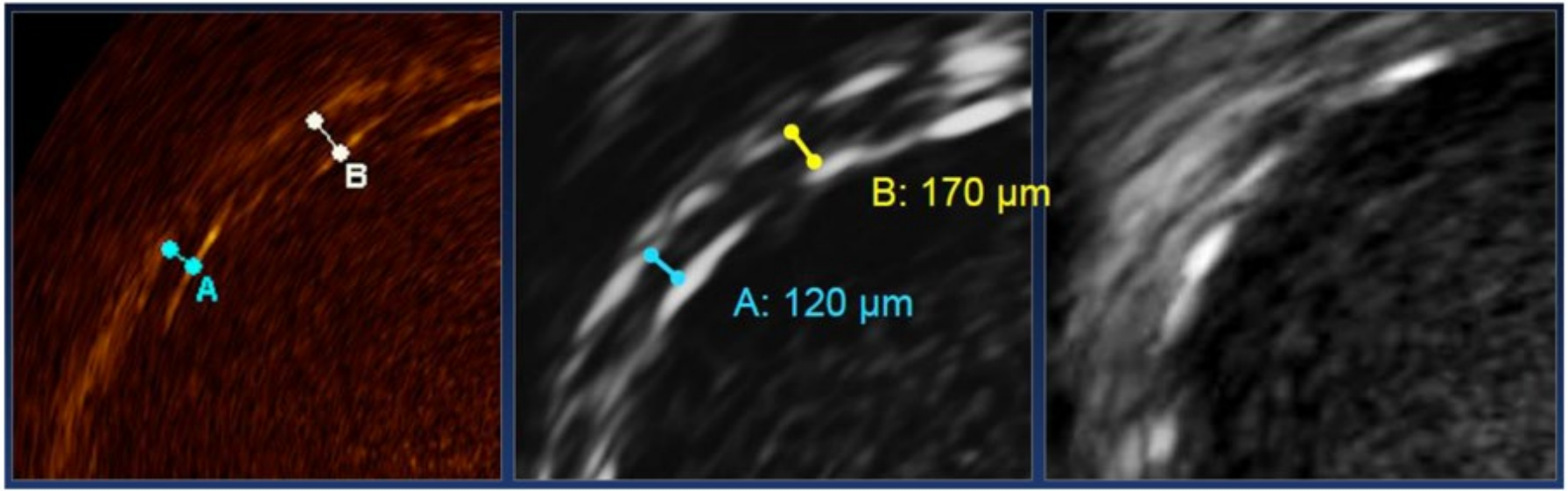






Promus
Element
4.0 * 20

Stent apposition: In vivo comparison



OCT
(with flush)

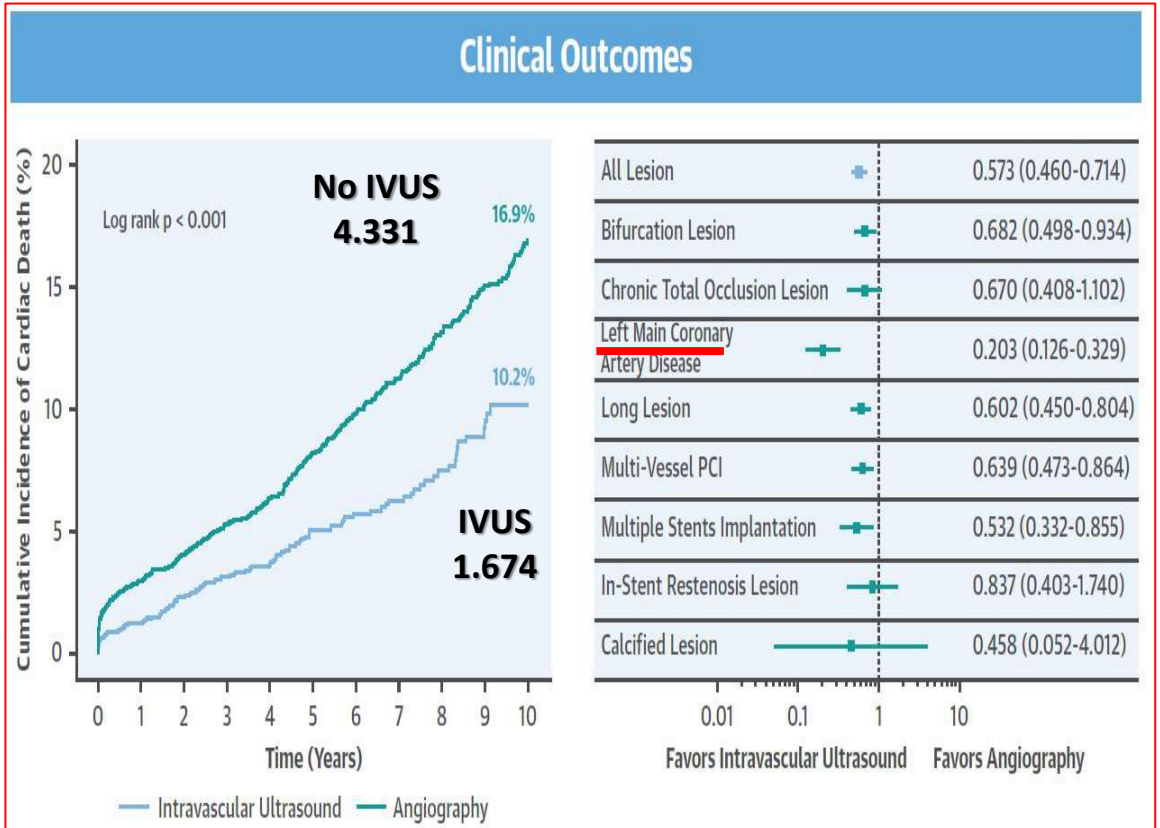
HD-IVUS 50 MHz
(in blood)

IVUS 40MHz
(in blood)

Impact of IVUS-Guided Percutaneous Coronary Intervention on Long-Term Clinical Outcomes in Patients Undergoing Complex Procedure

2019

Follow up @ 10 years



JACC Cardiovasc Interv. 2019 Apr 8;12(7):607-20

33,4%

REINTERVENCION DEL STENT

Artículo Original de Investigación

Optimización mediante ultrasonido intravascular de la angioplastia de tronco de coronaria izquierda

Optimization by intravascular ultrasound of left main coronary artery angioplasty

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Palabras clave:
Tronco de coronaria izquierda.
Angioplastia.
Stents liberadores de droga.
Ultrasonido intravascular.

RESUMEN

Introducción: La cirugía de revascularización miocárdica es el tratamiento convencional para pacientes (p) con lesión de tronco de coronaria izquierda no protegido (TCINP). La Angioplastia Transluminal Coronaria (ATC) con stents liberadores de droga (DES) es una opción factible, con bajas tasas de revascularización debido a reestenosis de la lesión tratada, y con mortalidad similar a la cirugía. **Objetivo:** Evaluar la efectividad de ATC con DES optimizada por ultrasonido intra-coronario (IVUS) en pacientes con enfermedad de TCINP.

Métodos: registro prospectivo consecutivo de p con lesión de TCINP tratados con ATC con DES guiada por IVUS. Se consideraron eventos combinados de muerte, infarto de miocardio, accidente cerebro-vascular (ACV) o revascularización de lesión tratada (RVT).

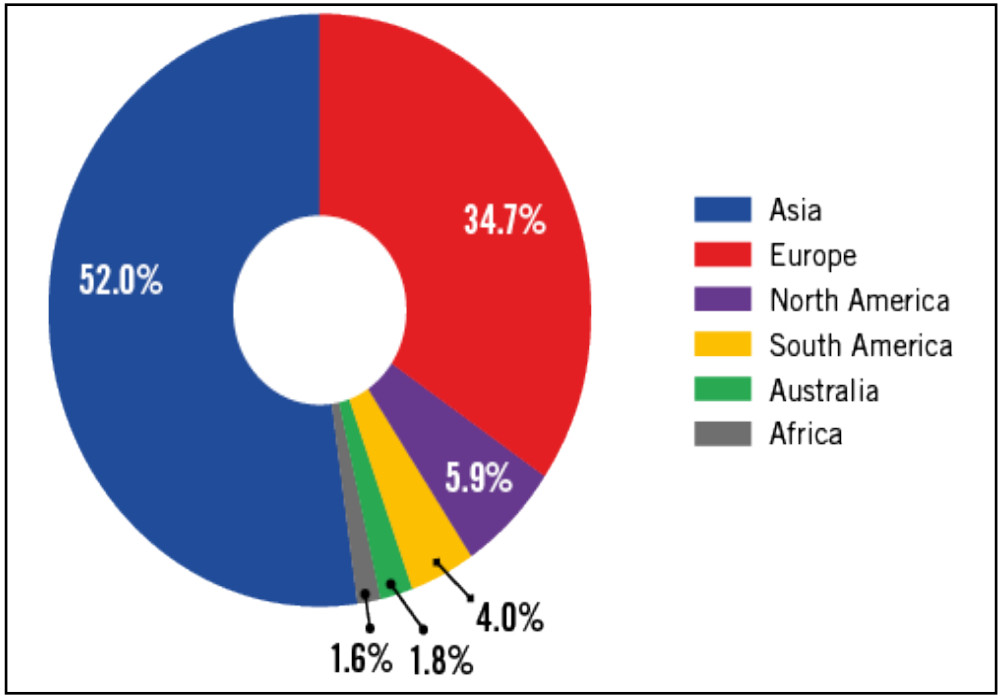
Resultados: 24 p, edad media 65,7±12,1 años; sexo masculino 83%, diabetes 21%. Enfermedad multi-vaso 88%. Lesión calcificada 13,6%. Fueron implantados 1,5 ± 0,85 stents/paciente. Syntax Score < 22 en 66,6%, 23-32 en 29,1%. Lesiones en bifurcaciones 87%. Implantados con técnica de stent provisional 77,3%. Area luminal media del DES 9,3 mm2. Re-intervención con balón por hipoexpansión y/o falta de aposición en pared 33,3%. Evolución intra-hospitalaria: 1 p infarto sub-clínico (4,1%). Seguimiento promedio 283 ± 63 días: 1 p IAM secundario a trombosis tardía de stent (2,7%). Mortalidad y ACV intrahospitalaria y alejada 0%.

Conclusiones: la ATC con DES optimizada con la guía de IVUS en lesiones de TCI NP en nuestra experiencia es un procedimiento seguro, con baja incidencia de complicaciones mayores intra-hospitalaria y alejadas, por lo que puede ser considerado una alternativa a la cirugía de revascularización miocárdica.

Optimization by intravascular ultrasound of left main coronary artery angioplasty

Current use of intracoronary imaging in interventional practice – Results of a European Association of Percutaneous Cardiovascular Interventions (EAPCI) and Japanese Association of Cardiovascular Interventions and Therapeutics (CVIT) Clinical Practice Survey

2022



Factors limiting the clinical use of IVUS / OCT

65.9 %	High cost
35 %	Prolongation of the diagnostic procedure or intervention
29.3 %	Regulatory issues (reimbursement)
17.1%	Lack of training for use and interpretation of these modalities
12.1%	Absence of established criteria for corrective measures based on 'abnormal' imaging findings
9.5 %	Risk of procedural complications
8.3 %	Clinical value is not established
8.6 %	I do not know

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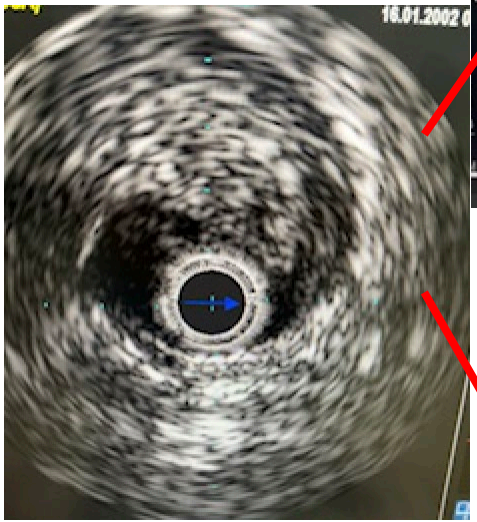
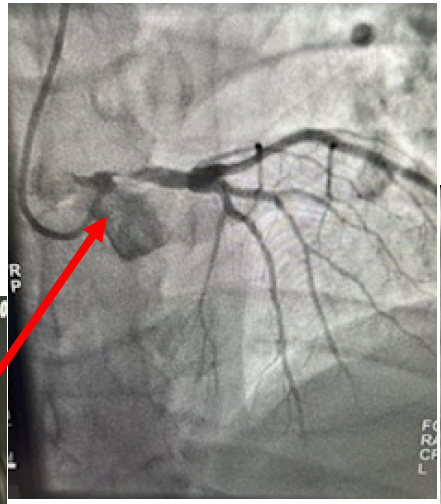
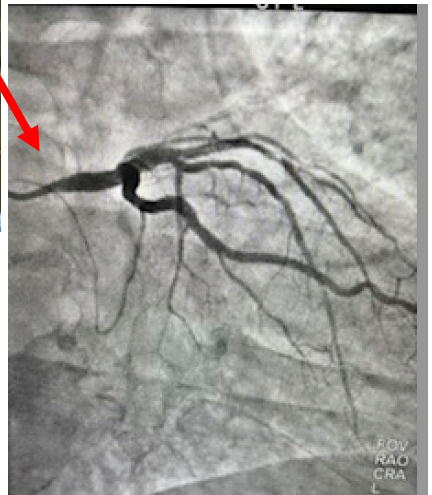
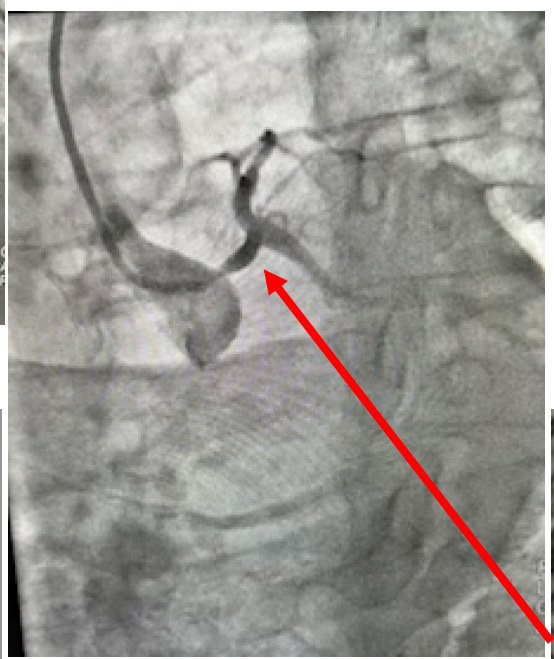
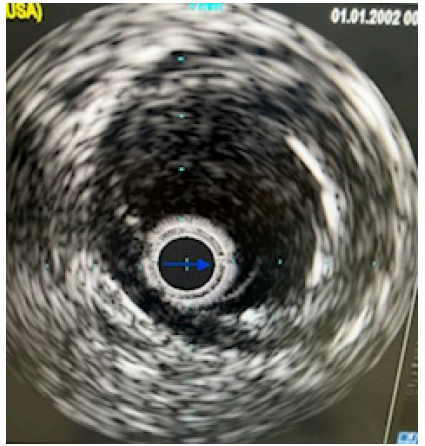
CASOS

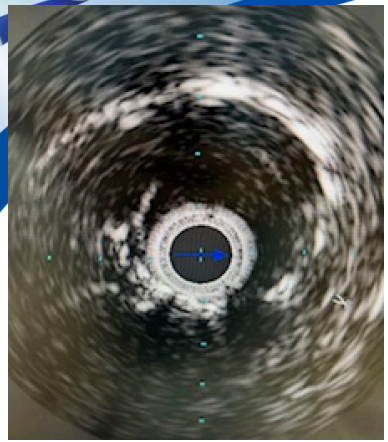


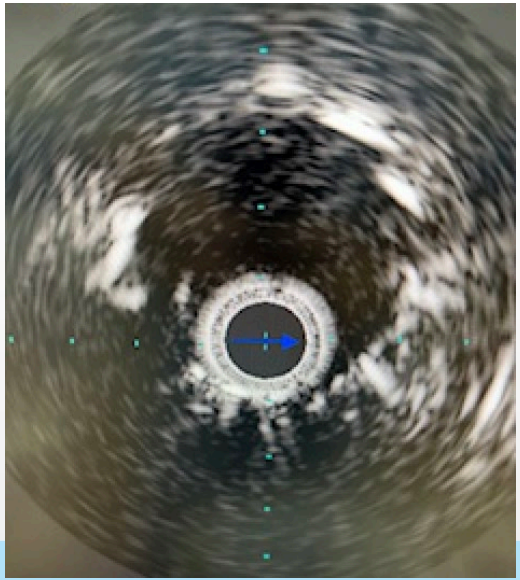


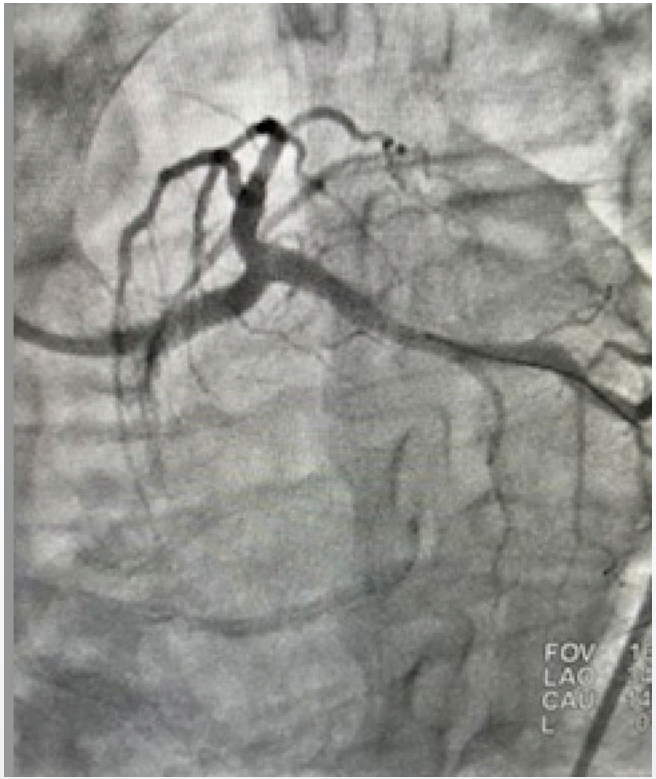


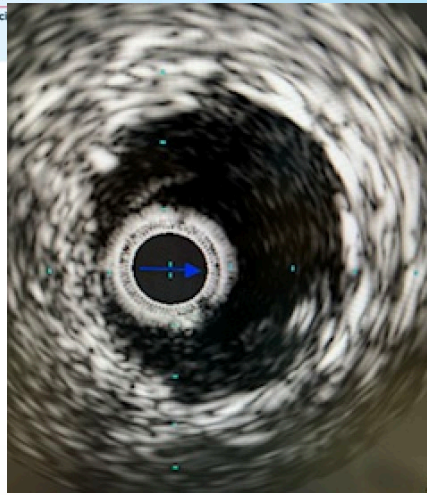


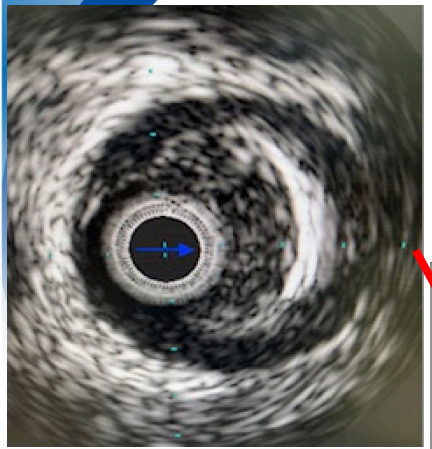


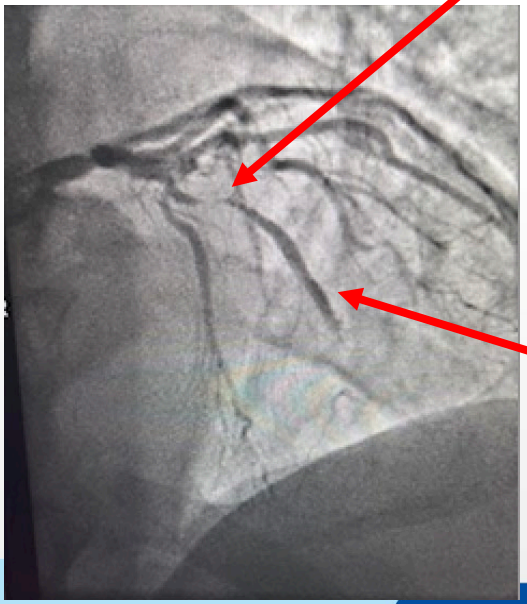


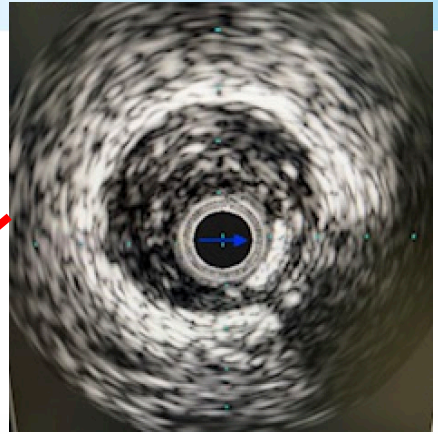


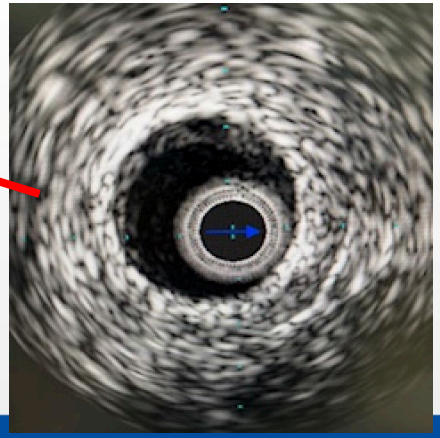












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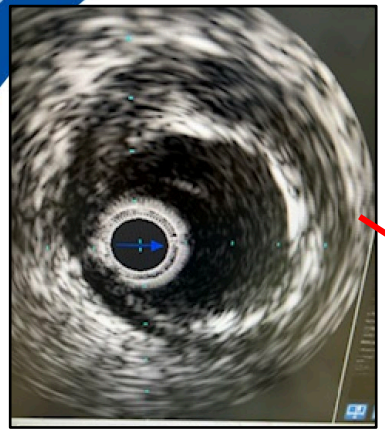
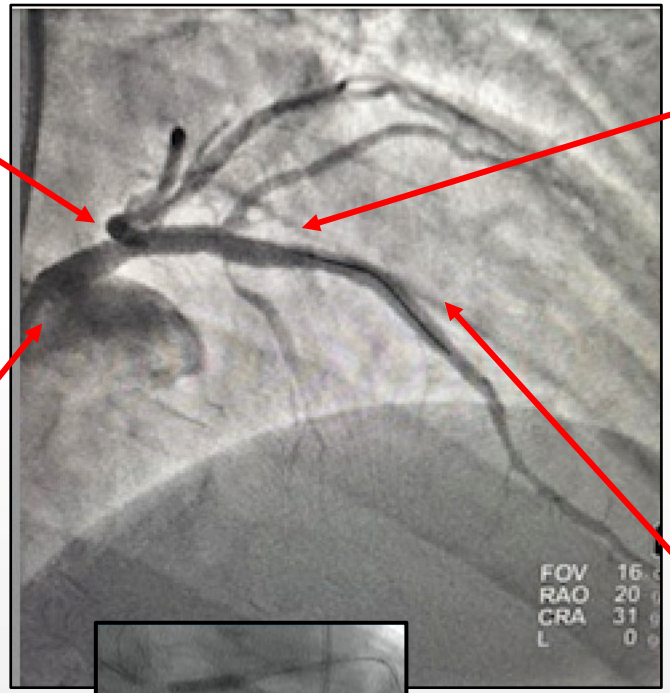
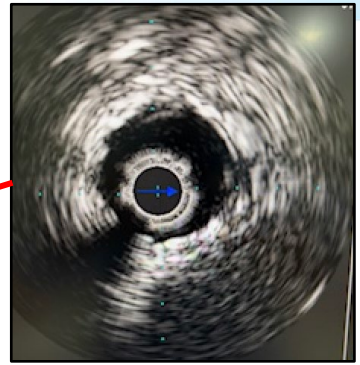
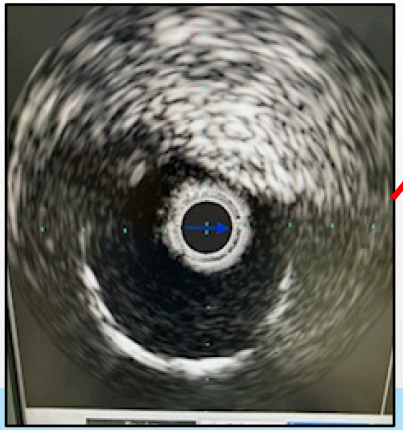
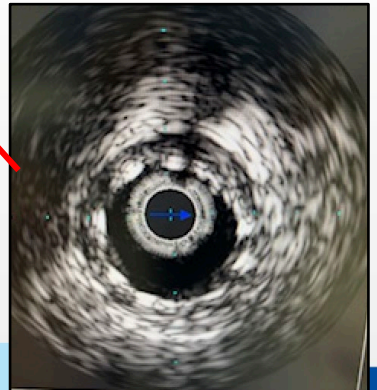
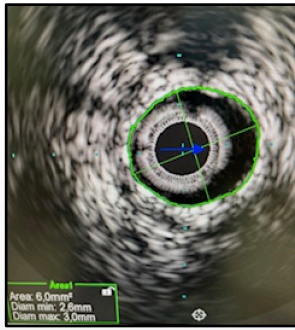






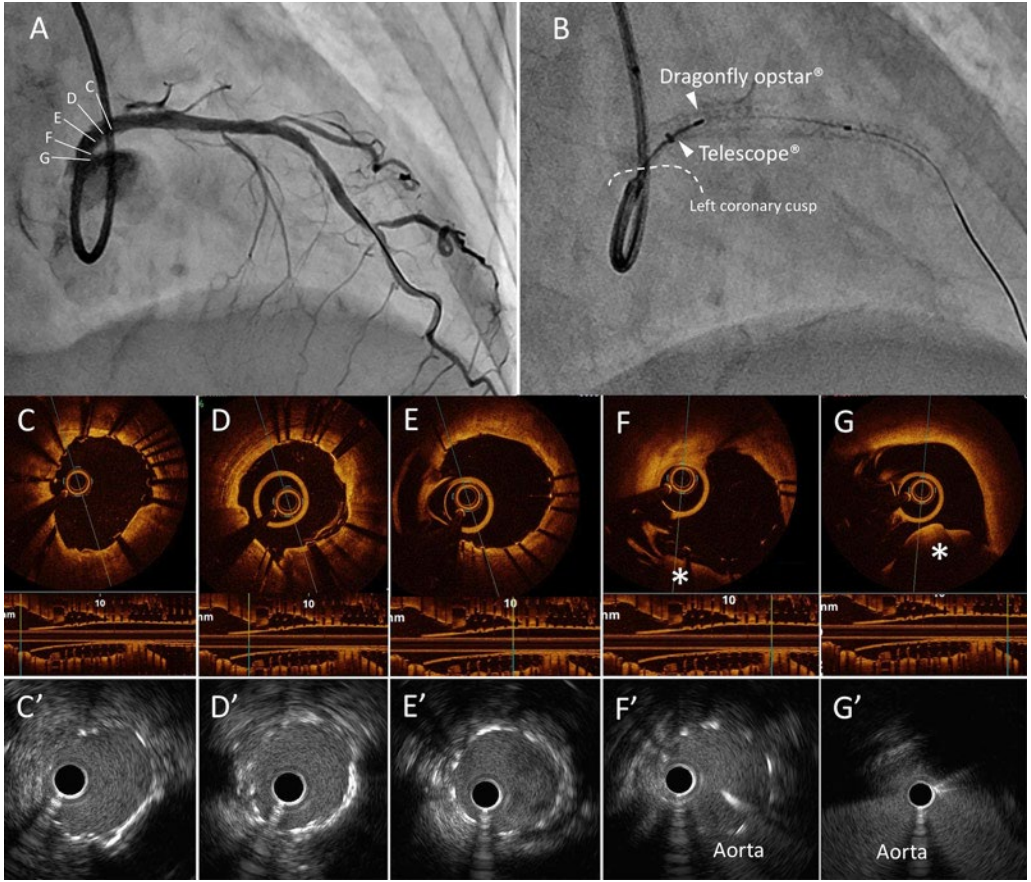






No existe una ventaja entre una modalidad y la otra: en términos de mejorar los resultados.

IVUS no requiere el uso de contraste para obtener la imagen.
OCT tiene una mejor resolución espacial, generando imágenes de mayor calidad y más fáciles de interpretar (más intuitiva que la IVUS).
OCT presenta cierta dificultad para adquirir imágenes en ciertos escenarios: OTC, lesiones aortoostiales (factible, pero desafiante), grandes disecciones agudas, etc.



Observing an aorto-ostial lesion using TELESCOPE® in optical coherence tomography-guided percutaneous coronary intervention

Comentarios finales

- Angioplastias guiadas por imágenes (IVUS), produce cambios en resultados largo plazo, en PCI complejas, especialmente en reducir revascularización de la lesión tratada.

- Para obtener estos beneficios, las imágenes deberían ser correctamente interpretadas, y los operadores deberían reaccionar a los resultados del IVUS.

- Guía por IVUS para lesiones complejas y lesion de TCI. **(Clase I evidencia A)**
  PRE intervención: evaluación vaso y características lesión
  POST intervención: expansión del Stent, aposición y complicaciones agudas (disección).

- Desde el momento que tomó su desición de darle el tiempo necesario para re evaluar su caso por IVUS, intente identificar las diferentes imágenes / complicaciones.

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La tensión de cizallamiento endotelial es la fuerza tangencial derivada de la fricción del flujo sanguíneo sobre la superficie endotelial y es el producto de la velocidad de cizallamiento en la pared y la viscosidad sanguínea. En regiones arteriales con flujo laminar alterado, una tensión de cizallamiento endotelial baja modifica la función y la estructura endotelial hacia un fenotipo aterosclerótico, promoviendo así la aterogénesis, la formación y progresión de la placa aterosclerótica y la remodelación vascular (recuadro azul)20, mientras que la carina está expuesta a una tensión de cizallamiento alta.

Efectos del bajo esfuerzo cortante

• Reducción de la producción de óxido nítrico y prostaciclina

• Aumento de la secreción de endotelina 1 • Promueve la captación, síntesis y permeabilidad del colesterol LDL • Promueve el estrés oxidativo y la inflamación

• Promueve la migración, proliferación y diferenciación de las células musculares lisas vasculares • Induce la degradación de la pared vascular y la capa fibrosa de la placa • Atenúa la síntesis de la matriz extracelular en la pared vascular y la capa fibrosa de la placa • Aumento de la neovascularización y calcificación de la placa • Aumenta la trombogenicidad de la placa

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Perspectiva global e histórica
Recordatorio de importancia Anatomía y fisiopatología.
Evidencia: PCI versus CABG en la enfermedad de LM.
Guias de revascularización.
Imágenes en LM PCI
Lesiones aorto-ostiales y de vasos medios
PCI ICP distal del LM.
Casos

La tensión de cizallamiento endotelial es la fuerza tangencial derivada de la fricción del flujo sanguíneo sobre la superficie endotelial y es el producto de la velocidad de cizallamiento en la pared y la viscosidad sanguínea. En regiones arteriales con flujo laminar alterado, una tensión de cizallamiento endotelial baja modifica la función y la estructura endotelial hacia un fenotipo aterosclerótico, promoviendo así la aterogénesis, la formación y progresión de la placa aterosclerótica y la remodelación vascular (recuadro azul)20, mientras que la carina está expuesta a una tensión de cizallamiento alta.

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Evidence: PCI vs CABG for LM

TABLE 1 Summary of Randomized Clinical Trials of PCI With DES Vs CABG for LMCA Disease

	LEMANS[30,31]	Boudriot et al[32]	SYNTAX-LM[33-35]	PRECOMBAT[36,38]	EXCEL[39,40]	NOBLE[41,42]
Recruitment period	2001-2004	2003-2009	2005-2007	2004-2009	2010-2014	2008-2015
PCI/CABG, n/n	52/53	100/101	357/348	300/300	948/957	592/592
Follow-up, y	10	1	5 10 (for mortality)	10	5	5
Diabetes, %	18	36	25	32	29	15
Bifurcation, %	58	72	61	64	81	81
SYNTAX score, mean	Not reported	23	30	25	21	22
Stent	BMS and DES (35%)	DP-SES	DP-PES	DP-SES	DP-EES	BP-BES and DP-SES (7.7%)
IVUS	Recommend	Infrequent	Infrequent	At discretion, 91%	Recommended, 77%	Recommended, 74%
FFR guidance	Not reported	Not reported	Infrequent	Not reported	Recommended, 9.0%	Recommended
LIMA, %	72	99	97	94	99	96
Off pump, %	1.9	46	Not reported	64	29	16
Primary trial endpoint	Change in LVEF	Cardiac death, MI, or TVR	Death, MI, stroke, or repeat revascularization 10-y all-cause death	Death, MI, stroke, or TVR	Death, MI, or stroke	Death, nonprocedural MI, stroke, or repeat revascularization
Key finding	There was a trend toward higher LVEF at 10 y with PCI.	PCI was inferior to CABG at 1 y.	PCI was noninferior to CABG at 1 and 5 y in terms of death, MI, stroke, or repeat revascularization. No significant difference in 10-y all-cause death between PCI and CABG.	PCI was noninferior to CABG at 1, 5, and 10 y.	PCI was noninferior to CABG at 3 and 5 y.	PCI was inferior to CABG at 5 y.

Park S, Park SJ, Park DW. Percutaneous Coronary Intervention for Left Main Coronary Artery Disease: Present Status and Future Perspectives.
JACC Asia. 2022 Mar 15;2(2):119-138. doi: 10.1016/j.jacasi.2021.12.011. PMID: 36339118; PMCID: PMC9627854.

Embarking on LMCA PCI

- Imaging is the foundation of LMCA PCI
  - Can help with diagnosing significant LMCA disease as well
- Consider LV support
  - No strict guide- ongoing studies will help
- Access
  - 7F radial guide have changed the landscape
- Volume drives outcomes
- Imaging is key- did we say that already?
- Comfort with evaluation and treatment of bifurcations is mandatory
  - To be discuss later in session

Guidelines

Left main CAD

1	B-R	3. In patients with SIHD and significant left main stenosis, CABG is recommended to improve survival (9-12).
2a	B-NR	4. In selected patients with SIHD and significant left main stenosis for whom PCI can provide equivalent revascularization to that possible with CABG, PCI is reasonable to improve survival (9).

ACC/AHA/SCAI

Left main CAD				
Left main disease with low SYNTAX score (0 - 22).[69,121,122,124,145–148]	I	A	I	A
Left main disease with intermediate SYNTAX score (23 - 32).[69,121,122,124,145–148]	I	A	IIa	A
Left main disease with high SYNTAX score (≥33).[c 69,121,122,124,146–148]	I	A	III	B

ESC

*CABG vs. DES for LMCAD: Meta-analysis of 5 trials**

Study and Year	Active Events	Active N	Control Events	Control N	Weight (%)	All Cause Death	Relative risk [95% CI]
NOBLE 6-year, 2019	54	592	50	592	22.4		1.06 [0.75, 1.50]
SYNTAX 10-year, 2019	93	357	96	348	32.9		0.93 [0.73, 1.16]
EXCEL 5-year, 2019	119	945	89	957	31.3		1.35 [1.04, 1.75]
PRECOMBAT 5-year, 2015	17	300	23	300	11.4		0.74 [0.40, 1.36]
Boudriot 1-year, 2011	2	100	5	101	2.0		0.40 [0.08, 2.00]
REML Model for all Studies (Q=7.26, df = 4, p for heterogeneity = 0.12, I^2 = 42.9%)							*1.03 [0.82, 1.30]*
							P for overall effect = 0.779

DES better < Relative risk > CABG better

**Mean weighted follow-up 5.6 years*

ESC European Society of Cardiology
European Heart Journal (2019) **40**, 87–165
doi:10.1093/eurheartj/ehy394

ESC/EACTS GUIDELINES

2018 ESC/EACTS Guidelines on myocardial revascularization

The Task Force on myocardial revascularization of the European Society of Cardiology (ESC) and European Association for Cardio-Thoracic Surgery (EACTS)

Developed with the special contribution of the European Association for Percutaneous Cardiovascular Interventions (EAPCI)

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CLINICAL PRACTICE GUIDELINE: FULL TEXT

2021 ACC/AHA/SCAI Guideline for Coronary Artery Revascularization

A Report of the American College of Cardiology/American Heart Association Joint Committee on Clinical Practice Guidelines

Recommendations on criteria for the choice between coronary artery bypass grafting and percutaneous coronary intervention

Recommendations	Class[a]	Level[b]
Assessment of surgical risk[c]		
It is recommended that the STS score is calculated to assess in-hospital or 30 day mortality, and in-hospital morbidity after CABG.[112,114,138]	I	B
Calculation of the EuroSCORE II score may be considered to assess in-hospital mortality after CABG.[112]	IIb	B
Assessment of CAD complexity		
In patients with LM or multivessel disease, it is recommended that the SYNTAX score is calculated to assess the anatomical complexity of CAD and the long-term risk of mortality and morbidity after PCI.[117–124]	I	B
When considering the decision between CABG and PCI, completeness of revascularization should be prioritized.[131,132,134–136]	IIa	B

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EuroSCORE = European System for Cardiac Operative Risk Evaluation; CABG = coronary artery bypass grafting; CAD = coronary artery disease; LM = left main; PCI = percutaneous coronary intervention; STS = Society of Thoracic Surgeons; SYNTAX = Synergy between Percutaneous Coronary Intervention with TAXUS and Cardiac Surgery.

[a]Class of recommendation.

[b]Level of evidence.

[c]Level of evidence refers to prediction of outcomes.

Recommendation for the type of revascularization in patients with stable coronary artery disease with suitable coronary anatomy for both procedures and low predicted surgical mortality[d]

Recommendations according to extent of CAD	CABG		PCI	
	Class[a]	Level[b]	Class[a]	Level[b]
One-vessel CAD				
Without proximal LAD stenosis.	IIb	C	I	C
With proximal LAD stenosis.[68,101,139–144]	I	A	I	A
Two-vessel CAD				
Without proximal LAD stenosis.	IIb	C	I	C
With proximal LAD stenosis.[68,70,73]	I	B	I	C
Left main CAD				
Left main disease with low SYNTAX score (0 - 22).[69,121,122,124,145–148]	I	A	I	A
Left main disease with intermediate SYNTAX score (23 - 32).[69,121,122,124,145–148]	I	A	IIa	A
Left main disease with high SYNTAX score (≥33).[c] [69,121,122,124,146–148]	I	A	III	B
Three-vessel CAD without diabetes mellitus				
Three-vessel disease with low SYNTAX score (0 - 22).[102,105,121,123,124,135,149]	I	A	I	A
Three-vessel disease with intermediate or high SYNTAX score (>22).[c] [102,105,121,123,124,135,149]	I	A	III	A
Three-vessel CAD with diabetes mellitus				
Three-vessel disease with low SYNTAX score 0–22.[102,105,121,123,124,135,150–157]	I	A	IIb	A
Three-vessel disease with intermediate or high SYNTAX score (>22).[c] [102,105,121,123,124,135,150–157]	I	A	III	A

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SYNTAX score calculation information is available at http://www.syntaxscore.com.
CABG = coronary artery bypass grafting; CAD = coronary artery disease; LAD = left anterior descending coronary artery; PCI = percutaneous coronary intervention; SYNTAX = Synergy between Percutaneous Coronary Intervention with TAXUS and Cardiac Surgery.
[a]Class of recommendation.
[b]Level of evidence.
[c]PCI should be considered if the Heart Team is concerned about the surgical risk or if the patient refuses CABG after adequate counselling by the Heart Team.
[d]For example, absence of previous cardiac surgery, severe morbidities, frailty, or immobility precluding CABG (also see *Table 5*).

La CRM es un tratamiento convencional para pacientes (p) con lesión de TCI.

La ATC con stents liberadores de droga (DES) es en una opción factible, con bajas tasas de reestenosis, y con mortalidad similar a la cirugía.

2018 ESC/EACTS Guidelines on myocardial revascularization

Recommendations according to extent of CAD	CABG		PCI	
	Class[a]	Level[b]	Class[a]	Level[b]
One-vessel CAD				
Without proximal LAD stenosis.	IIb	C	I	C
With proximal LAD stenosis.[68,101,139–144]	I	A	I	A
Two-vessel CAD				
Without proximal LAD stenosis.	IIb	C	I	C
With proximal LAD stenosis.[68,70,73]	I	B	I	C
Left main CAD				
Left main disease with low SYNTAX score (0 - 22).[69,121,122,124,145–148]	I	A	I	A
Left main disease with intermediate SYNTAX score (23 - 32).[69,121,122,124,145–148]	I	A	IIa	A
Left main disease with high SYNTAX score (≥33).[c] [69,121,122,124,146–148]	I	A	III	B
Three-vessel CAD without diabetes mellitus				
Three-vessel disease with low SYNTAX score (0 - 22).[102,105,121,123,124,135,149]	I	A	I	A
Three-vessel disease with intermediate or high SYNTAX score (>22).[c] [102,105,121,123,124,135,149]	I	A	III	A
Three-vessel CAD with diabetes mellitus				
Three-vessel disease with low SYNTAX score 0–22.[102,105,121,123,124,135,150–157]	I	A	IIb	A
Three-vessel disease with intermediate or high SYNTAX score (>22).[c] [102,105,121,123,124,135,150–157]	I	A	III	A

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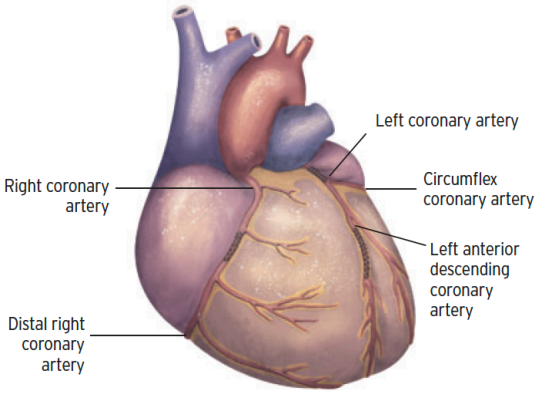
Anatomically and clinically based recommendations for revascularization in CCS	Class[a]	Level[b]
Left main disease		
In CCS patients at low surgical risk[c] with significant left main coronary stenosis, CABG:		
• is recommended over medical therapy alone to improve survival;[719]	I	A
• is recommended as the overall preferred revascularization mode over PCI, given the lower risk of spontaneous myocardial infarction and repeat revascularization.[728,730,782]	I	A
In CCS patients with significant left main coronary stenosis of low complexity (SYNTAX score ≤22), in whom PCI can provide equivalent completeness of revascularization to that of CABG, PCI is recommended as an alternative to CABG, given its lower invasiveness and non-inferior survival.[718,728,730,802,813]	I	A
In CCS patients with significant left main coronary stenosis of intermediate complexity (SYNTAX score 23–32), in whom PCI can provide equivalent completeness of revascularization to that of CABG, PCI should be considered, given its lower invasiveness and non-inferior survival.[718,728,730,802,805,809,813,820,822]	IIa	A
Left main with multivessel disease[d]		
In CCS patients at low surgical risk with suitable anatomy, CABG is recommended over medical therapy alone to improve survival.[718,719,870]	I	A
In CCS patients at high surgical risk, PCI may be considered over medical therapy alone.[728,813]	IIb	B

TABLE 3 Recent Changes of PCI Recommendation Guidelines for LMCA Disease

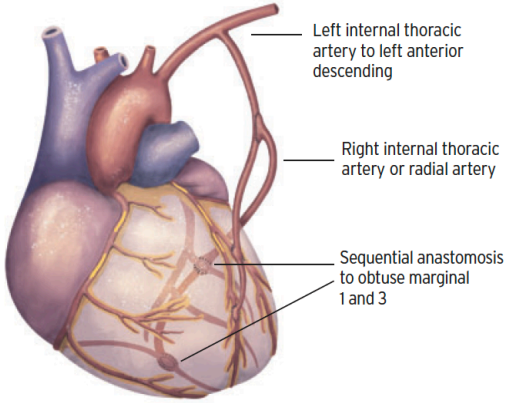
Guidelines	Class of Recommendation	Level of Evidence
Pre-EXCEL and NOBLE		
2014 ESC/EACTS[55]	I: LMCA disease with a SYNTAX score of ≤22 IIa: LMCA disease with a SYNTAX score of 23-32 III: LMCA disease with a SYNTAX score of ≥33	B
2014 ACC/AHA[57]	IIa: For SIHD patients when both of the following are present: • Anatomic conditions associated with a low risk of PCI procedural complications and a high likelihood of good long-term outcomes (eg, a low SYNTAX score of ≤22, ostial or trunk LMCA stenosis) • Clinical characteristics that predict a significantly increased risk of adverse surgical outcomes (eg, STS-predicted risk of operative mortality of >5%) IIb: For SIHD patients when both of the following are present: • Anatomic conditions associated with a low-to intermediate risk of PCI procedural complications and an intermediate to high likelihood of good long-term outcome (eg, low-intermediate SYNTAX score of <33, distal bifurcation LMCA stenosis) • Clinical characteristics that predict an increased risk of adverse surgical outcomes (eg, moderate-severe chronic obstructive pulmonary disease, disability from previous stroke, or previous cardiac surgery; STS-predicted risk of operative mortality of >2%) III: For SIHD patients (vs performing CABG) with unfavorable anatomy for PCI and who are good candidates for CABG	B B B
Post-EXCEL and NOBLE		
2018 ESC/EACTS[56]	I: LMCA disease with a SYNTAX score of ≤22 IIa: LMCA disease with a SYNTAX score of 23-32 III: LMCA disease with a SYNTAX score of ≥33	A
2021 ACC/AHA[58]	IIa: In selected patients with SIHD and significant LMCA disease for whom PCI can provide equivalent revascularization to that possible with CABG, PCI is reasonable to improve survival.	B

ACC = American College of Cardiology; AHA = American Heart Association; EACTS = European Association for Cardio-Thoracic Surgery; ESC = European Society of Cardiology; SIHD = stable ischemic heart disease; STS = Society of Thoracic Surgeons; other abbreviations as in Tables 1 and 2.

PCI



CABG



FAVOURS PCI

Clinical characteristics

Presence of severe co-morbidity (not adequately reflected by scores)

Advanced age/frailty/reduced life expectancy

Restricted mobility and conditions that affect the rehabilitation process

Anatomical and technical aspects

MVD with SYNTAX score 0–22

Anatomy likely resulting in incomplete revascularization with CABG due to poor quality or missing conduits

Severe chest deformation or scoliosis

Sequelae of chest radiation

Porcelain aorta[a]

FAVOURS CABG

Clinical characteristics

Diabetes

Reduced LV function (EF ≤35%)

Contraindication to DAPT

Recurrent diffuse in-stent restenosis

Anatomical and technical aspects

MVD with SYNTAX score ≥23

Anatomy likely resulting in incomplete revascularization with PCI

Severely calcified coronary artery lesions limiting lesion expansion

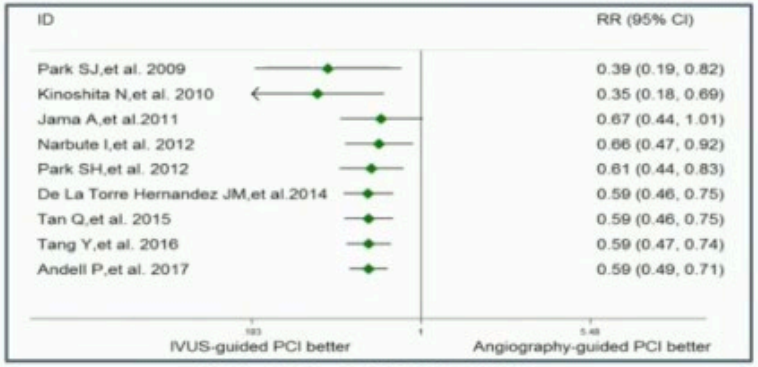
Need for concomitant interventions

Ascending aortic pathology with indication for surgery

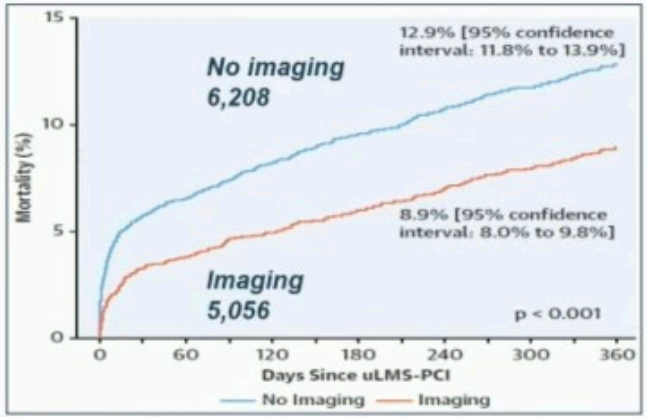
Concomitant cardiac surgery

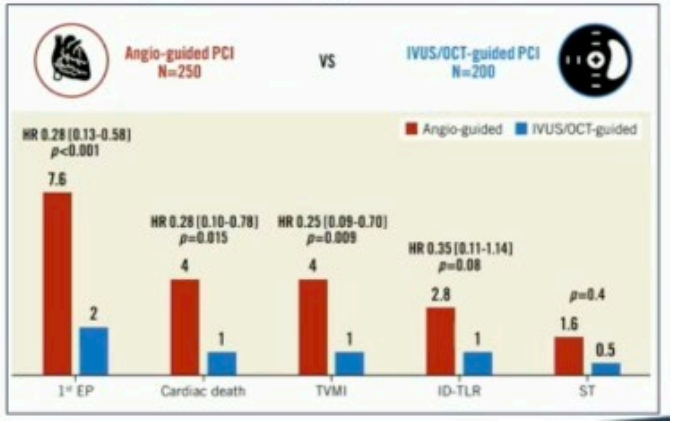
©ESC 2018

Registries show consistent benefits for IVUS guided LM PCI

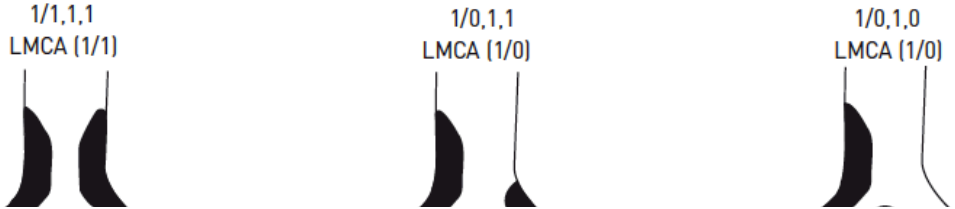


Ye Y, et al. PLoS ONE 12(6): e0179756.

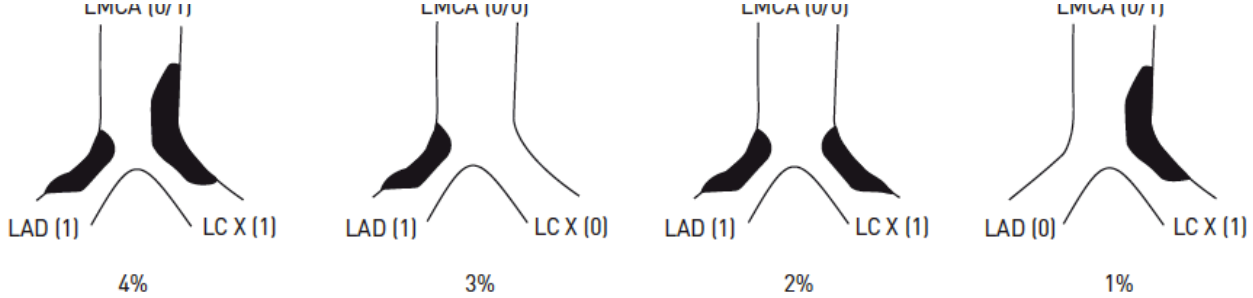




Anatomy and pathophysiology



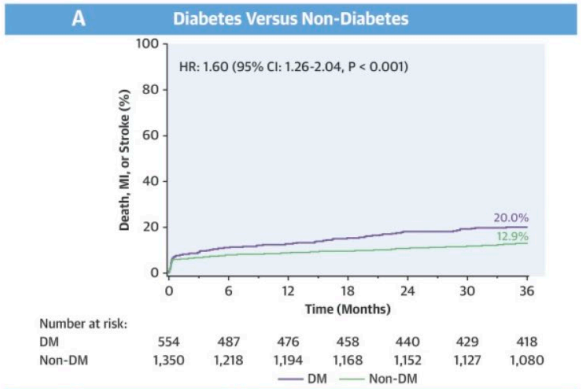
Continuous involvement from the distal LMS into the proximal LAD is present in 90% of cases.

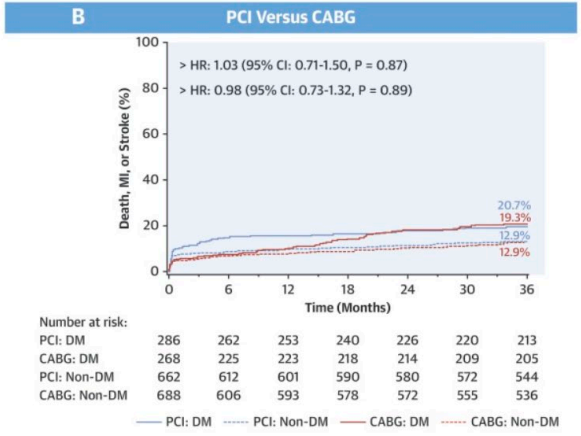


Oviedo C, et al. Intravascular ultrasound classification of plaque distribution in left main coronary artery bifurcations: where is the plaque really located? *Circ Cardiovasc Interv.* 2010;3:105-12

Impacto de Diabetes Mellitus a 3 años de revascularización de TCI

CENTRAL ILLUSTRATION: Impact of Diabetes Mellitus on 3-Year Outcomes After Left Main Revascularization





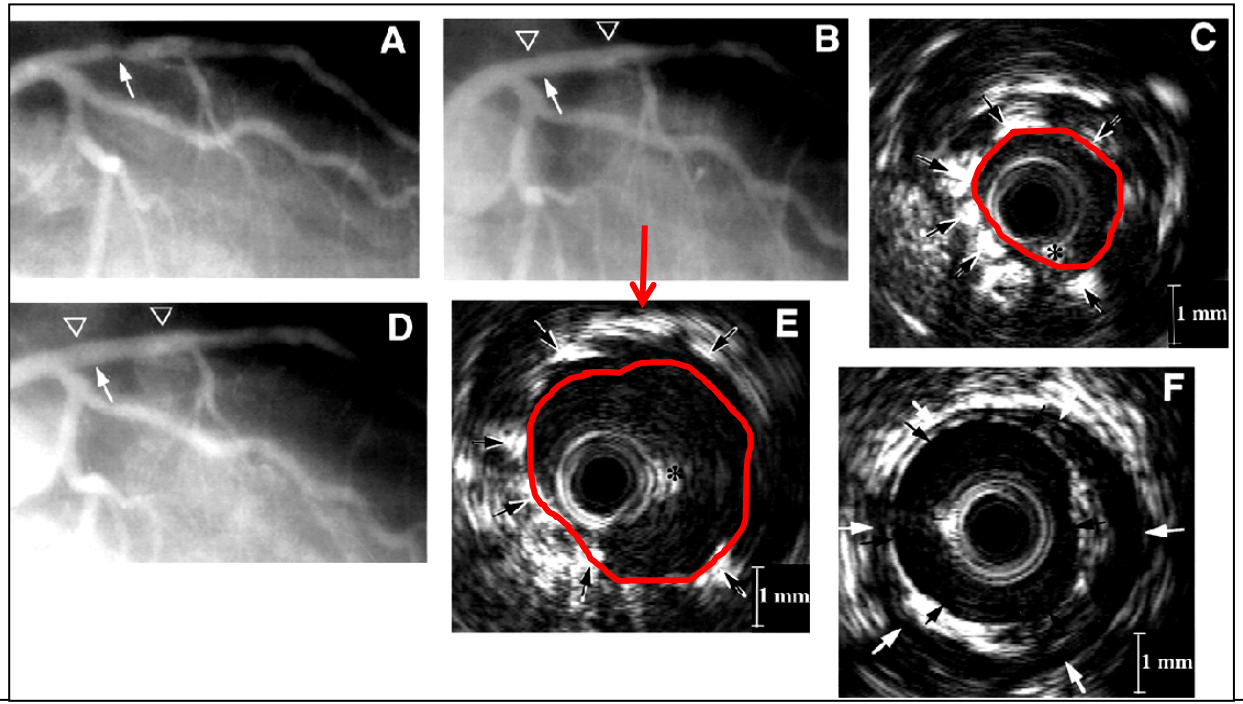
Milojevic, M. et al. J Am Coll Cardiol. 2019;73(13):1616-28.

Recommendations for Patients With Diabetes
Referenced studies that support the recommendations are summarized in Online Data Supplement 14.

COR	LOE	RECOMMENDATIONS
1	A	1. In patients with diabetes and multivessel CAD with the involvement of the LAD, who are appropriate candidates for CABG, CABG (with a LIMA to the LAD) is recommended in preference to PCI to reduce mortality and repeat revascularizations (1-8).
2a	B-NR	2. In patients with diabetes who have multivessel CAD amenable to PCI and an indication for revascularization and are poor candidates for surgery, PCI can be useful to reduce long-term ischemic outcomes (9,10).
2b	B-R	3. In patients with diabetes who have left main stenosis and low- or intermediate-complexity CAD in the rest of the coronary anatomy, PCI may be considered an alternative to CABG to reduce major adverse cardiovascular outcomes (5,11).

Intracoronary Stenting Without Anticoagulation Accomplished With Intravascular Ultrasound Guidance

Antonio Colombo, MD; Patrick Hall, MD; Shigeru Nakamura, MD; Yaron Almagor, MD; Luigi Maiello, MD; Giovanni Martini, CCP; Antonio Gaglione, MD; Steven L. Goldberg, MD; Jonathan M. Tobis, MD

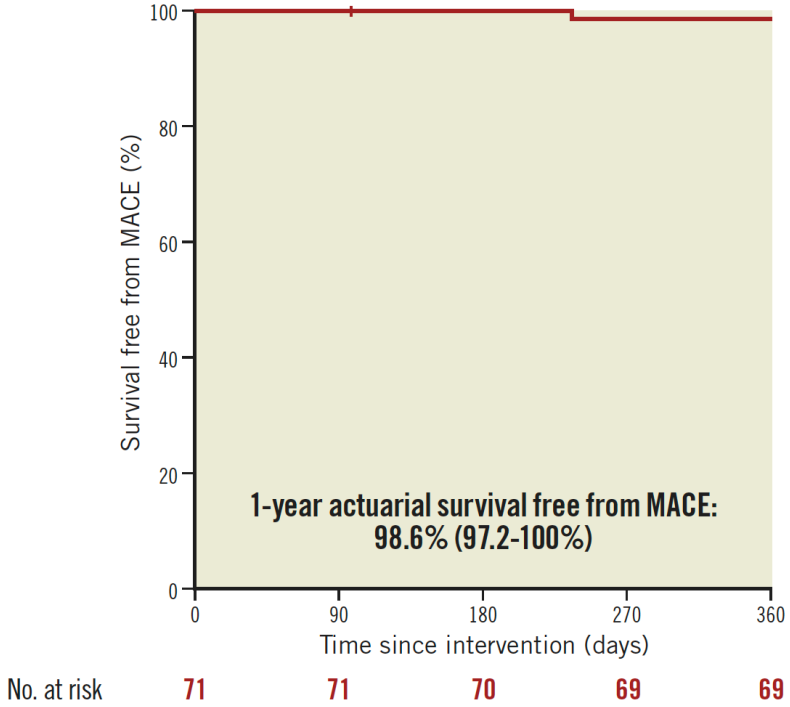


Despite this aggressive inflation approach, 40% of the stents with an acceptable angiographic result still required additional dilatation with higher pressures or, less commonly, a dilatation with a larger balloon

IVUS in LM PCI: tips.

- JL4 guiding catheter*
- Coaxial positioning of the guide catheter tip is essential to allow appropriate visualization of all LM layers.
- Decannulation of the guide catheter from the LMS is usually required.
- In cases of tight lesions can cause severe ischemia/hemodynamic instability.
- Ensure the image depth is increased to the maximum.
- For LMS bifurcation analyses:
  Wire both LAD and LCx. This will potentially allow for the appropriate visualization of the carina/ostia (by reducing the bifurcation angle) as it would appear after implantation with a metallic stent.

OCT in LM PCI: LEMON trial



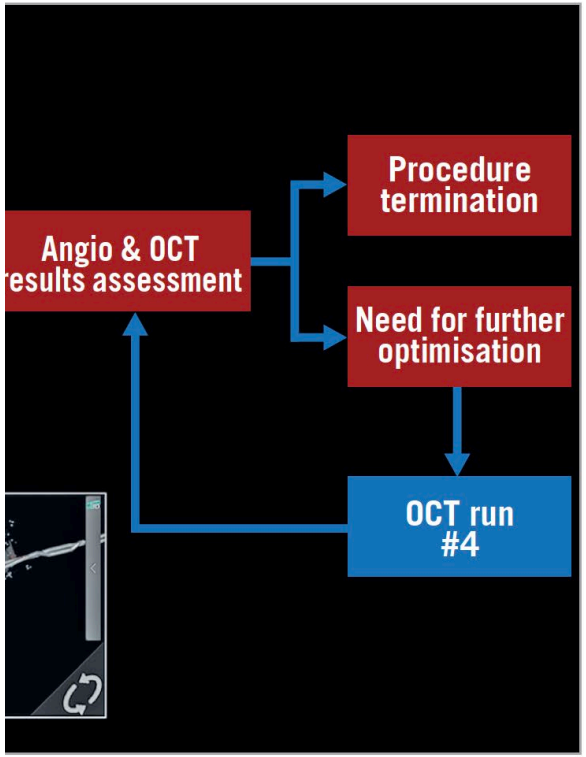
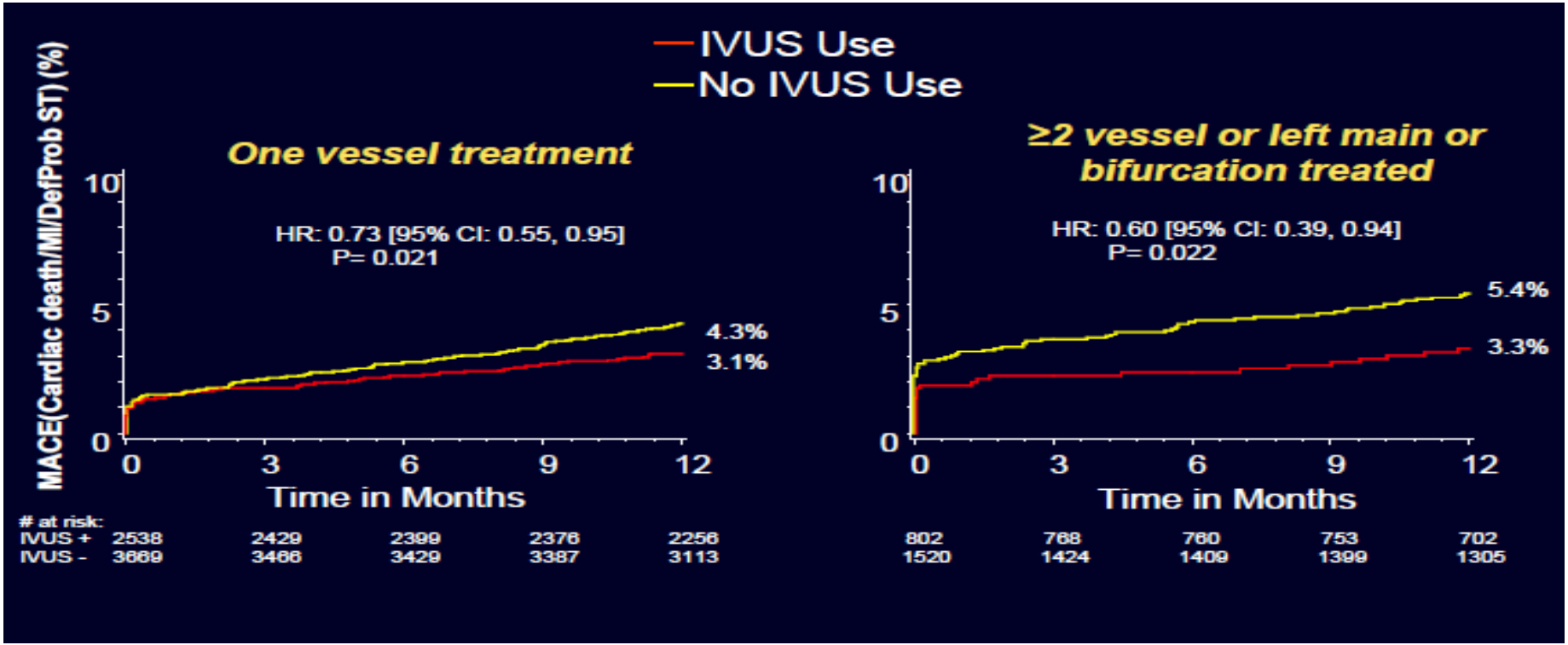


Figure 3. *One-year incidence of MACE (cardiovascular death/target vessel revascularisation/stent thrombosis) in the LEMON cohort.*

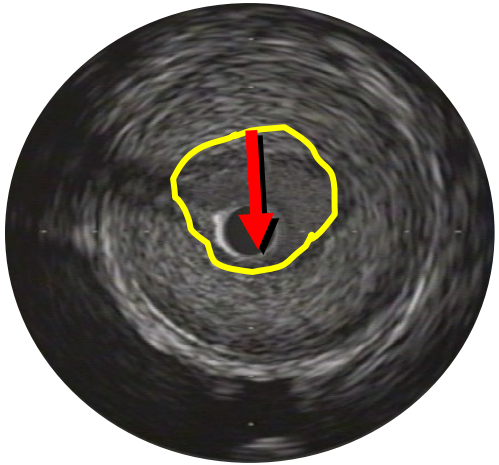
ATC Compleja: ADAPT-DES



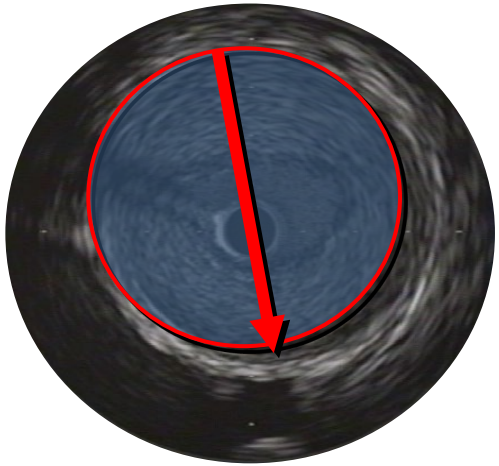
Witzenbichler et al. Circulation 2014;129:463-70

DIAGNÓSTICO

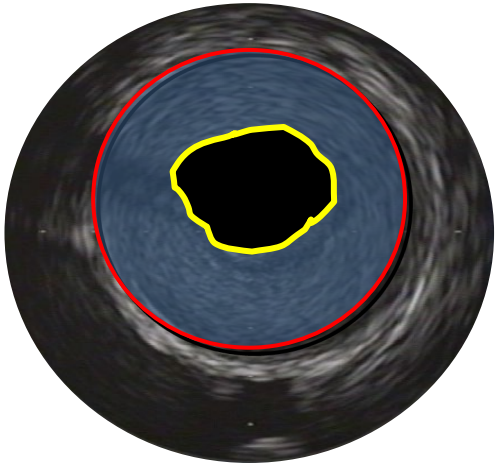
1) Evaluación de lesiones Intermedias



Área Luminal - mm²



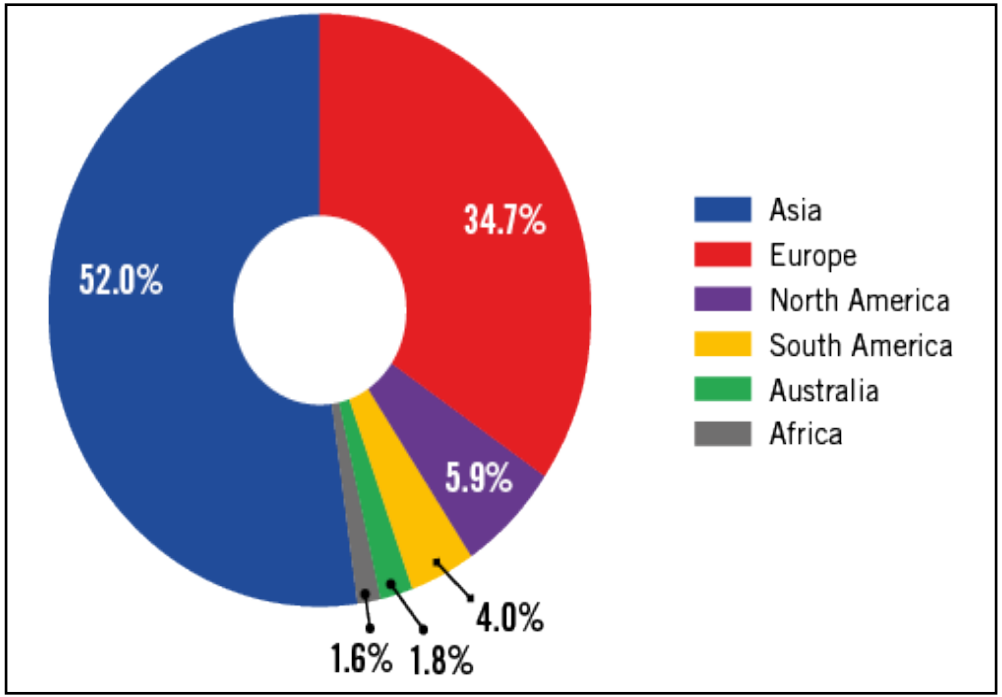
Área Total do Vaso



Área da Placa

Current use of intracoronary imaging in interventional practice – Results of a European Association of Percutaneous Cardiovascular Interventions (EAPCI) and Japanese Association of Cardiovascular Interventions and Therapeutics (CVIT) Clinical Practice Survey

2022

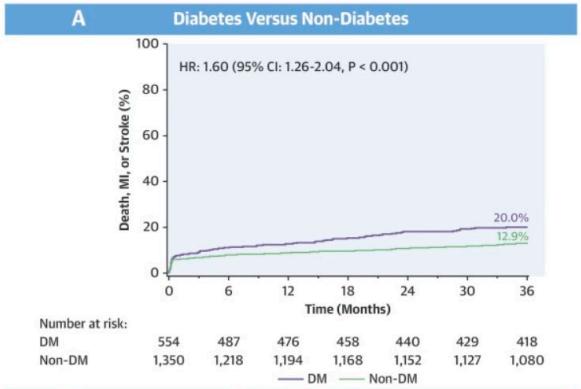


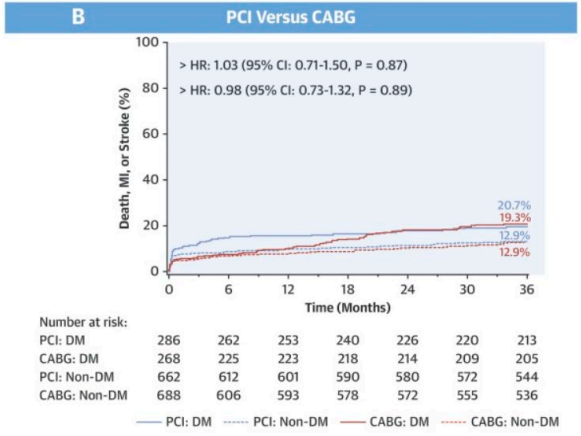
Factors limiting the clinical use of IVUS / OCT

65.9 %	High cost
35 %	Prolongation of the diagnostic procedure or intervention
29.3 %	Regulatory issues (reimbursement)
17.1%	Lack of training for use and interpretation of these modalities
12.1%	Absence of established criteria for corrective measures based on 'abnormal' imaging findings
9.5 %	Risk of procedural complications
8.3 %	Clinical value is not established
8.6 %	I do not know

Impacto de Diabetes Mellitus a 3 años de revascularización de TCI

CENTRAL ILLUSTRATION: Impact of Diabetes Mellitus on 3-Year Outcomes After Left Main Revascularization





Milojevic, M. et al. J Am Coll Cardiol. 2019;73(13):1616-28.

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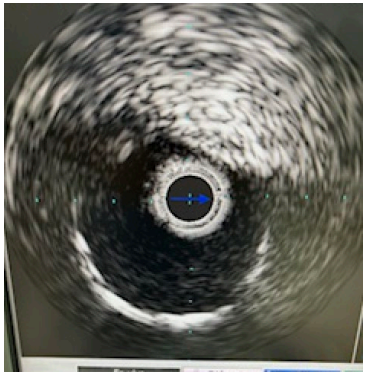
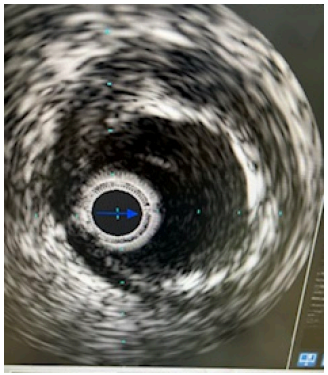
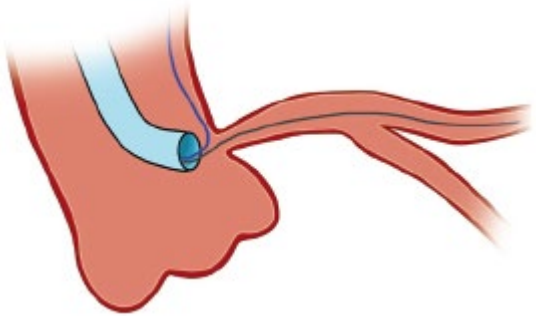
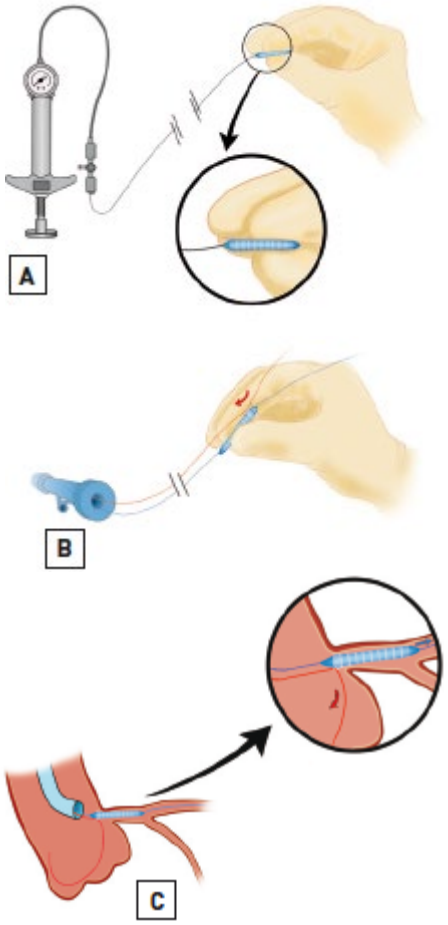


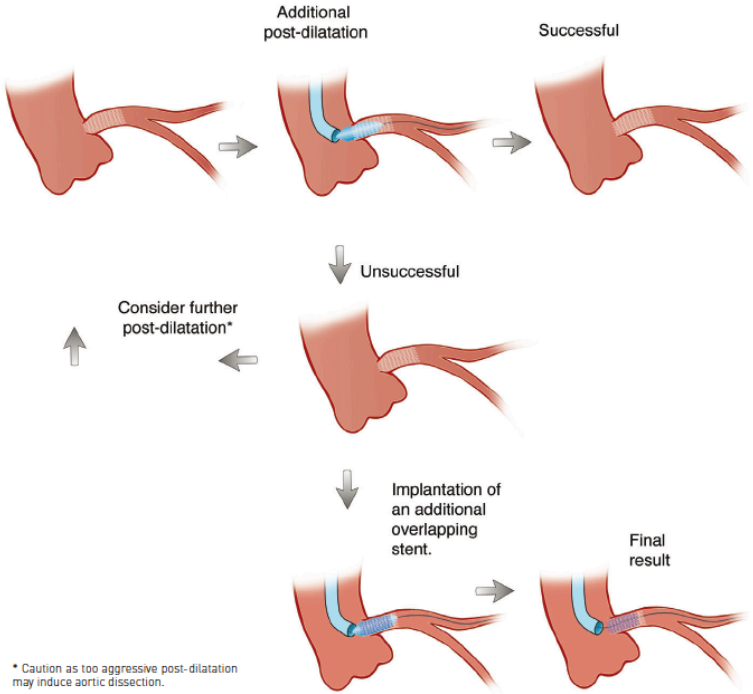


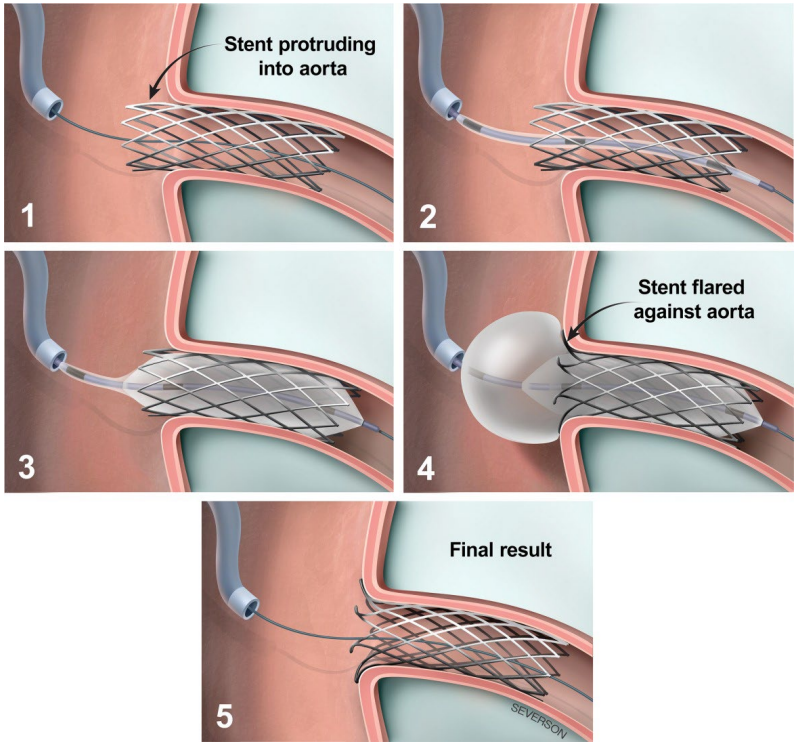
Aorto-ostial and mid-vessel



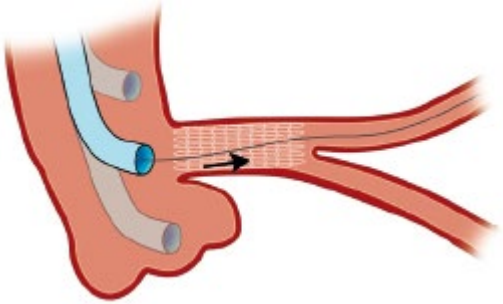


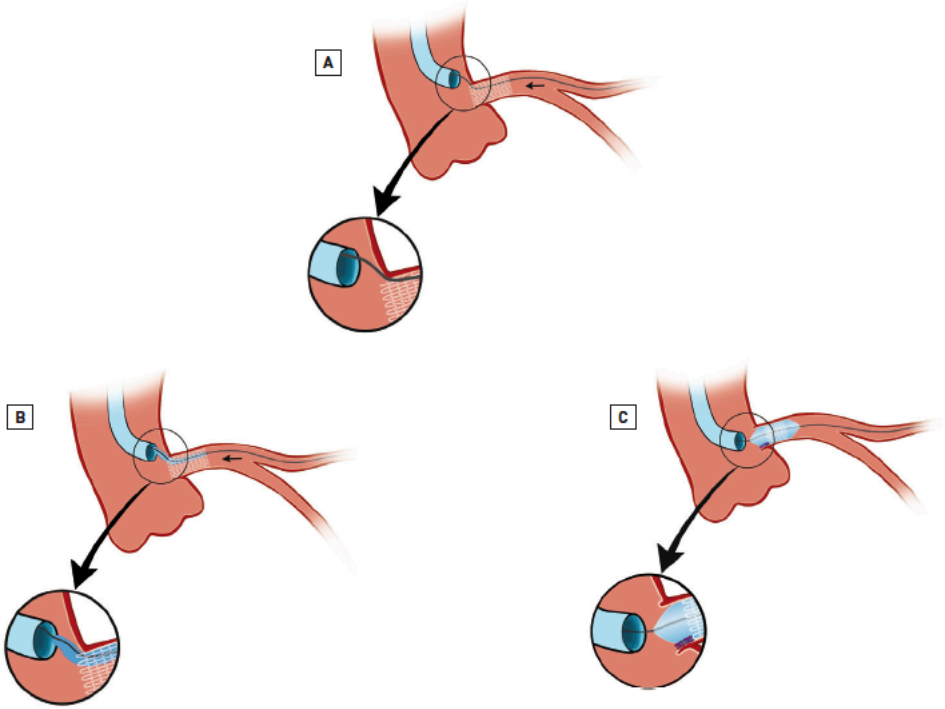
Aorto-ostial and mid-vessel lesions





Aorto-ostial and mid-vessel lesions





Distal LM lesions: DKCRUSH-III Trial

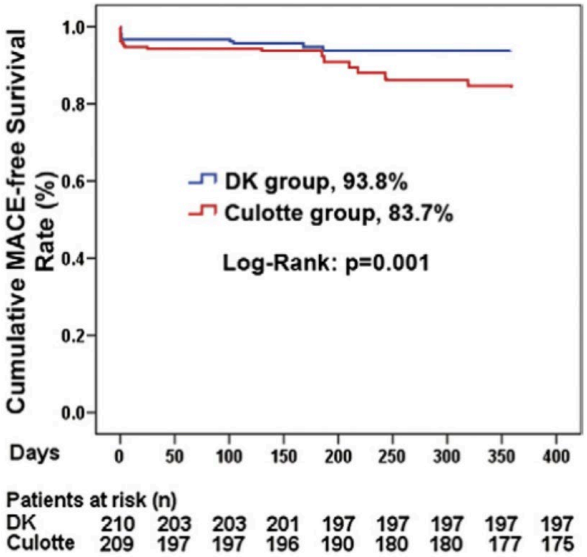


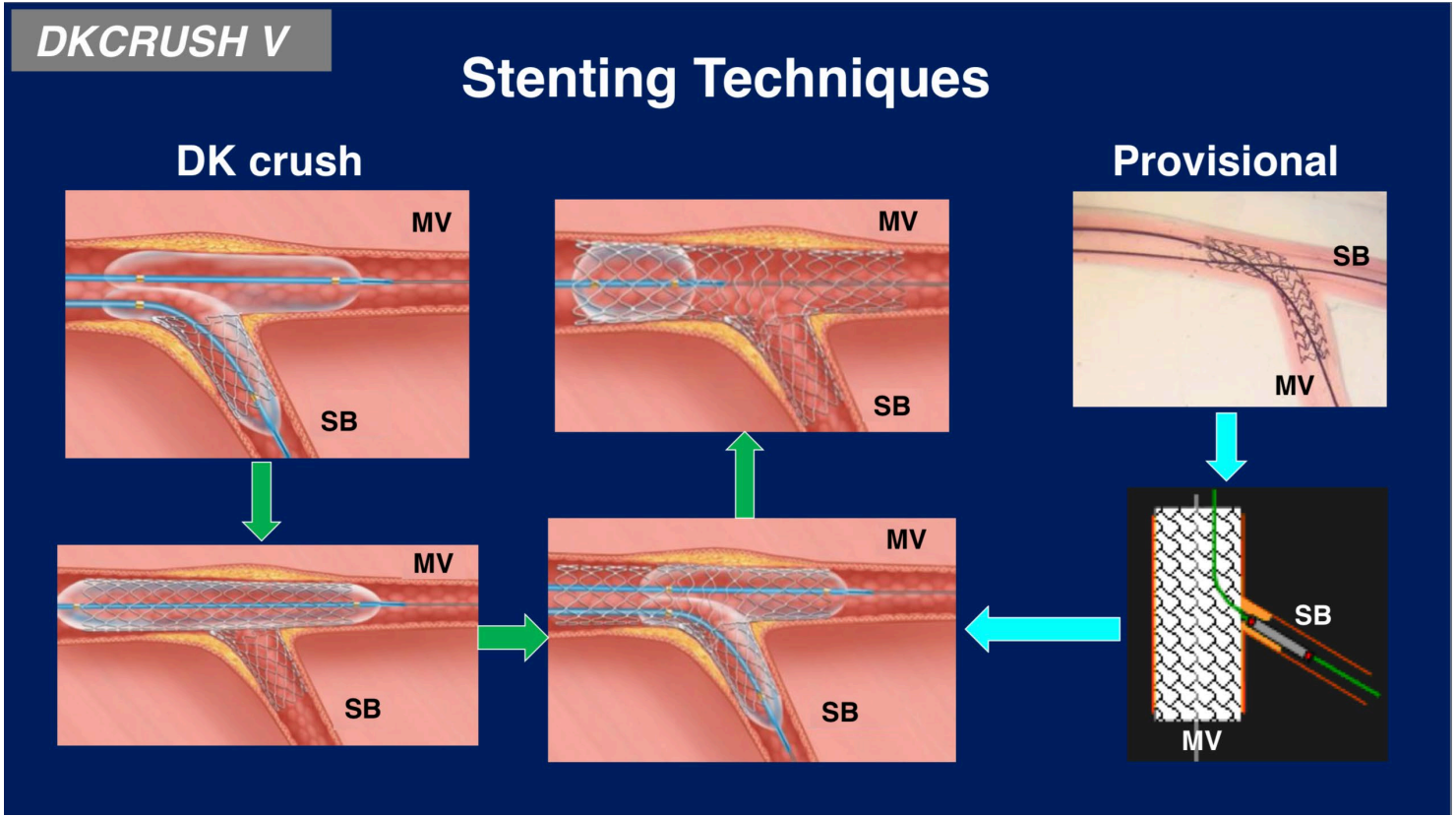
Figure 5 **MACE-Free Survival Rate at 12 Months**

Rate was 83.7% in the Culotte group, and it was 93.8% in the double kissing (DK) group (p = 0.001). MACE = major adverse cardiac event.

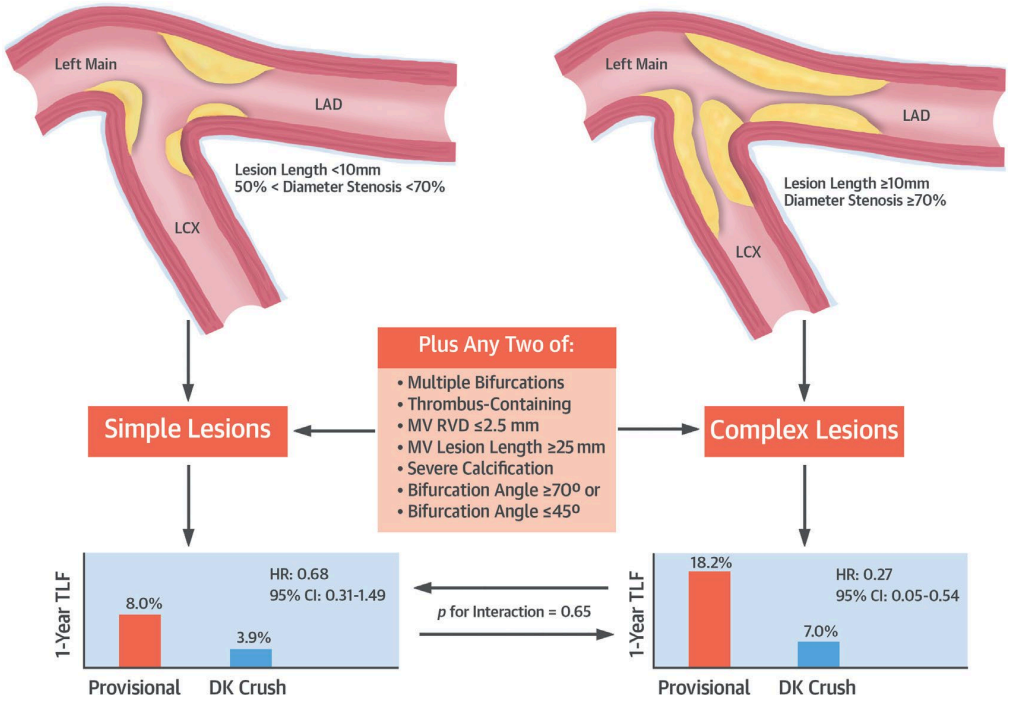
Chen SL, et al. Comparison of double kissing crush versus Culotte stenting for unprotected distal left main bifurcation lesions: results from a multicenter, randomized, prospective DKCRUSH-III study. J Am Coll Cardiol. 2013 Apr 9;61(14):1482-8. doi: 10.1016/j.jacc.2013.01.023. Epub 2013 Mar 10. PMID: 23490040.

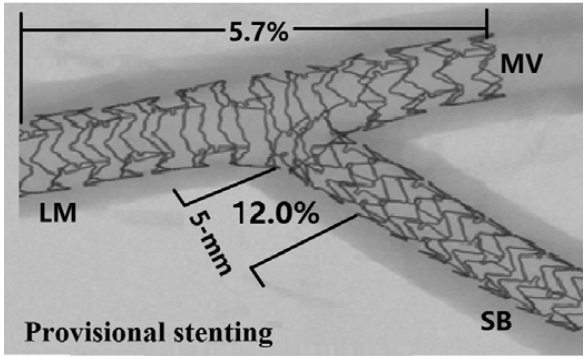
DKCRUSH V

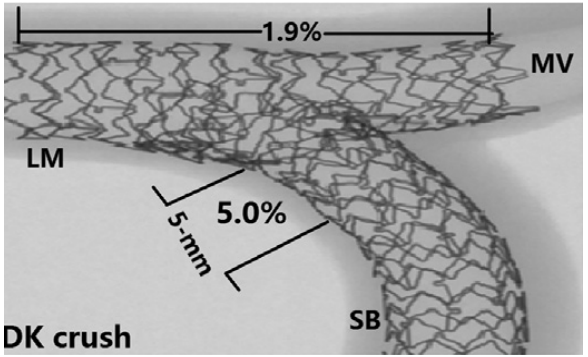
Stenting Techniques



Distal LM lesions: DKCRUSH-V Trial

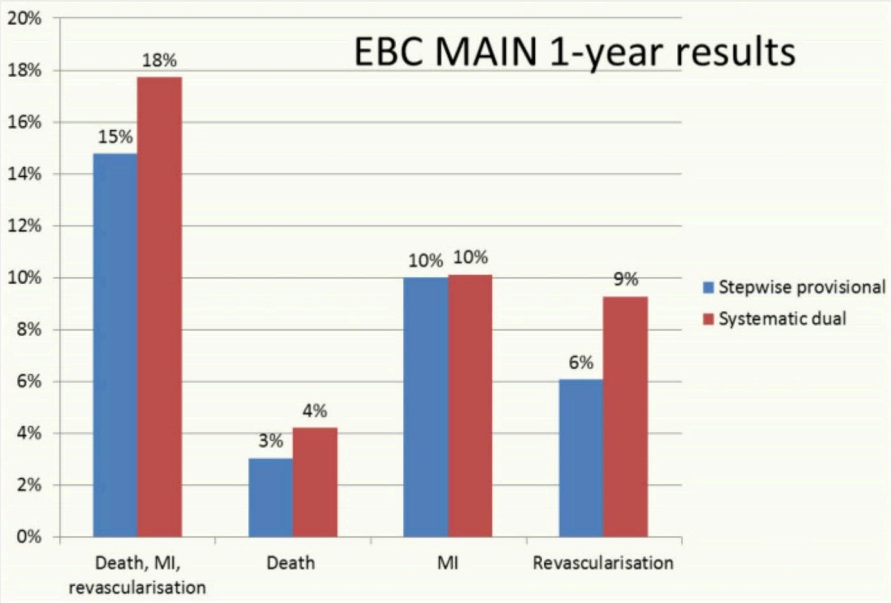






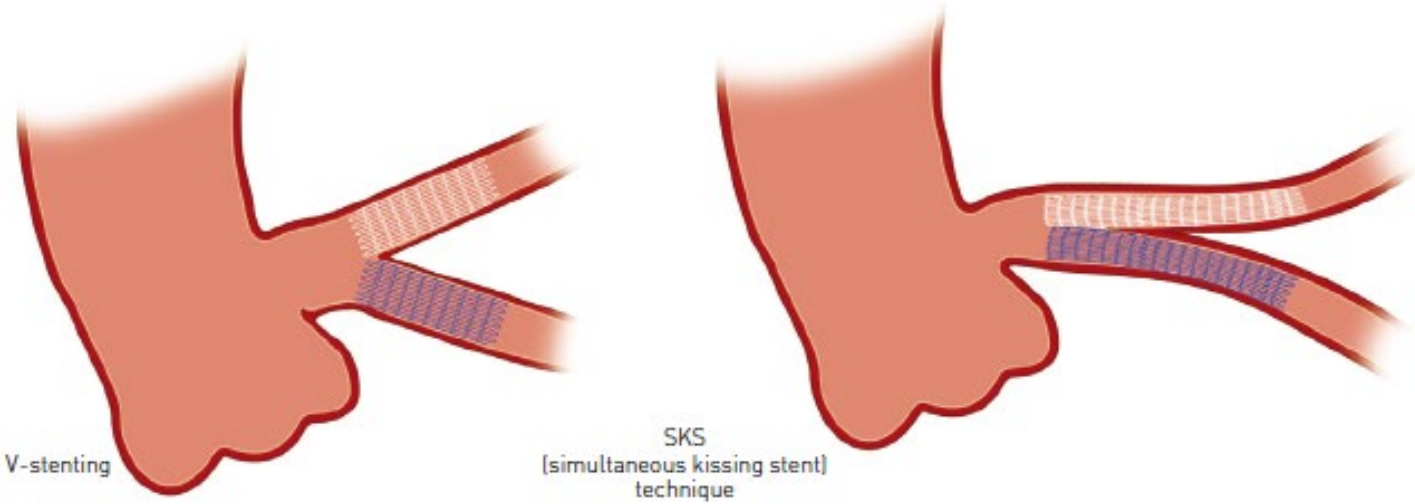
Chen SL, et al. Double Kissing Crush Versus Provisional Stenting for Left Main Distal Bifurcation Lesions: DKCRUSH-V Randomized Trial. J Am Coll Cardiol. 2017 Nov 28;70(21):2605-2617. doi: 10.1016/j.jacc.2017.09.1066. Epub 2017 Oct 30. PMID: 29096915.

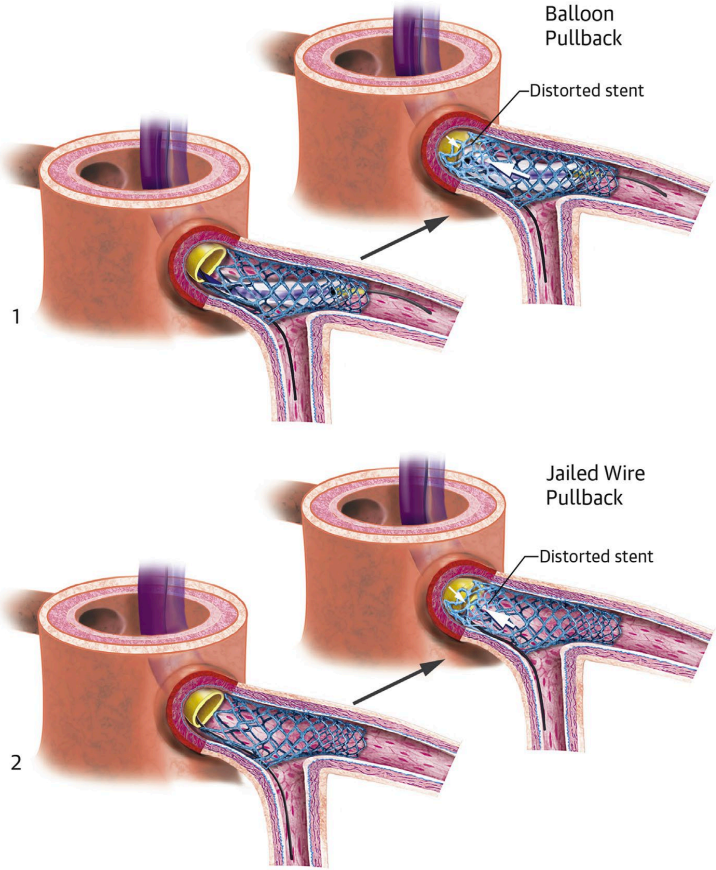
Distal LM lesions: EBC MAIN trial



Compared with a dual stent strategy, numerically (but not statistically) fewer major adverse cardiac events occurred with the stepwise provisional approach.

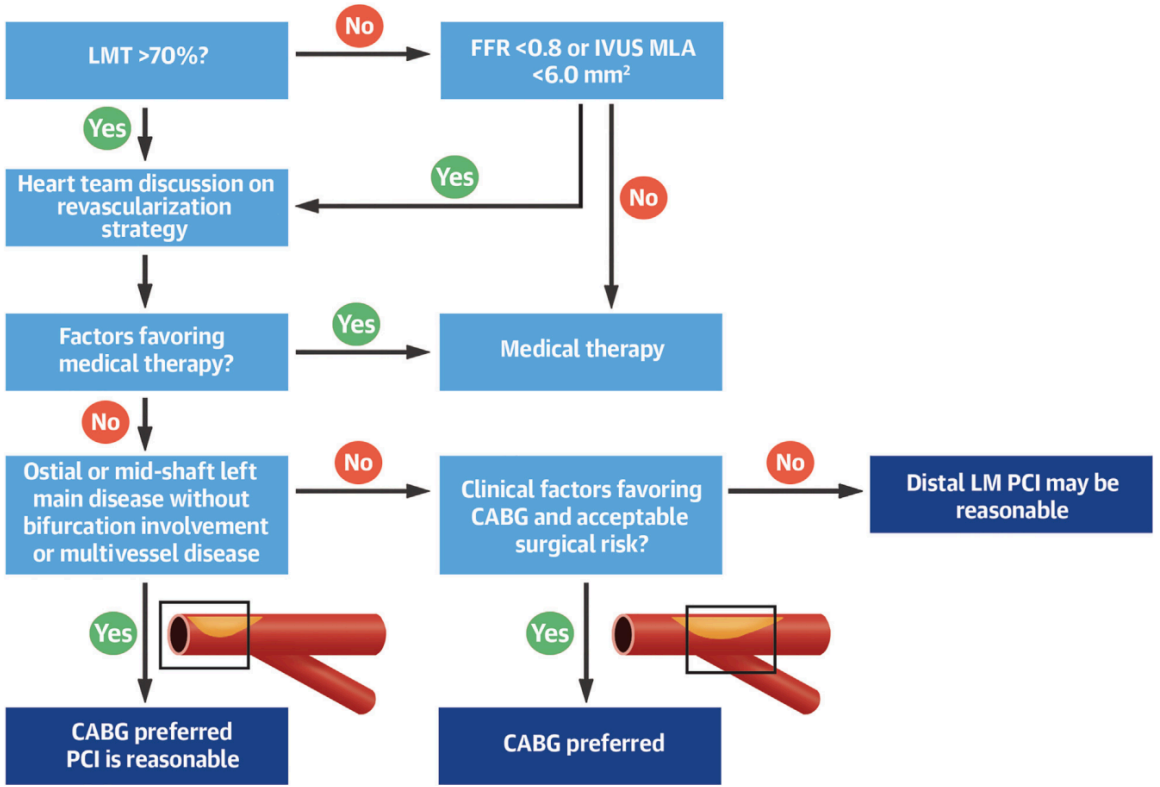
Hildick-Smith D, Egred M, Banning A, Brunel P, Ferenc M, Hovasse T, Wlodarczak A, Pan M, Schmitz T, Silvestri M, Erglis A, Kretov E, Lassen JF, Chieffo A, Lefèvre T, Burzotta F, Cockburn J, Darremont O, Stankovic G, Morice MC, Louvard Y. The European bifurcation club Left Main Coronary Stent study: a randomized comparison of stepwise provisional vs. systematic dual stenting strategies (EBC MAIN). Eur Heart J. 2021 Oct 1;42(37):3829-3839. doi: 10.1093/eurheartj/ehab283. PMID: 34002215.


V-stenting
SKS
(simultaneous kissing stent)
technique


Balloon
Pullback
Distorted stent
1
Jailed Wire
Pullback
Distorted stent
2

ARRÊT
STOP

CENTRAL ILLUSTRATION Left Main Coronary Artery Disease Clinical Decision-Making Algorithm



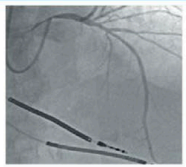
Davidson LJ, et al. J Am Coll Cardiol. 2022;80(22):2119–2134.

This algorithm outlines a clinical approach that may be utilized by clinicians to assist with decision-making for patients who present with left main coronary artery disease. Medical therapy, percutaneous coronary intervention (PCI), or coronary artery bypass grafting (CABG) may be reasonable strategies depending on each patient's clinical history, anatomy, and preferences.

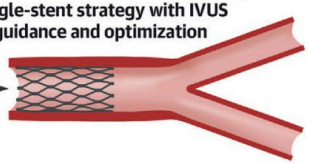
Davidson LJ, Cleveland JC, Welt FG, Anwaruddin S, Bonow RO, Firstenberg MS, Gaudino MF, Gersh BJ, Grubb KJ, Kirtane AJ, Tamis-Holland JE, Truesdell AG, Windecker S, Taha RA, Malaisrie SC. A Practical Approach to Left Main Coronary Artery Disease: JACC State-of-the-Art Review. J Am Coll Cardiol. 2022 Nov 29;80(22):2119-2134. doi: 10.1016/j.jacc.2022.09.034. PMID: 36423996.

Left Main PCI and Lesion Anatomy, Morphology, and Complexity: Technical Considerations for PCI in Left Main Disease

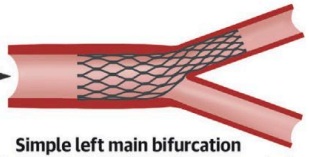
Ostial or mid-shaft (nonbifurcation)



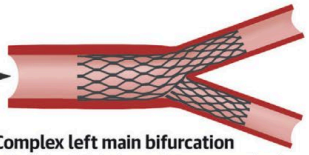
Ostial or mid-shaft (nonbifurcation): Single-stent strategy with IVUS guidance and optimization



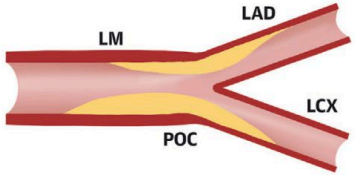
Distal left main bifurcation (eg Medina 1,1,1 or 0,1,1)



Simple left main bifurcation (and low-risk of side branch compromise): Provisional single-stent strategy with IVUS guidance or optimization



Complex left main bifurcation (and high-risk of side branch compromise): Up-front 2-stent strategy (eg, DK-Crush, Culotte, T-and-Protrusion) with IVUS guidance and optimization to include KBI and POT



Left main coronary artery lesion angiography and intravascular imaging characteristics include:

- Lesion length
- Lesion diameter
- Lesion location (eg, shaft vs bifurcation)
- Bifurcation vessel (eg, LAD and/or LCX) involvement
- Bifurcation angle
- Plaque burden and morphology (eg, calcification)

Davidson LJ, Cleveland JC, Welt FG, Anwaruddin S, Bonow RO, Firstenberg MS, Gaudino MF, Gersh BJ, Grubb KJ, Kirtane AJ, Tamis-Holland JE, Truesdell AG, Windecker S, Taha RA, Malaisrie SC. A Practical Approach to Left Main Coronary Artery Disease: JACC State-of-the-Art Review. J Am Coll Cardiol. 2022 Nov 29;80(22):2119-2134. doi: 10.1016/j.jacc.2022.09.034. PMID: 36423996.