

Learning Case and Technique Reviews

Management of Left Main Disease. Step-by-step

José María Hernández
Hospital Vithas Xanit Internacional
Málaga . España

CLINICAL CASE

72-year-old woman

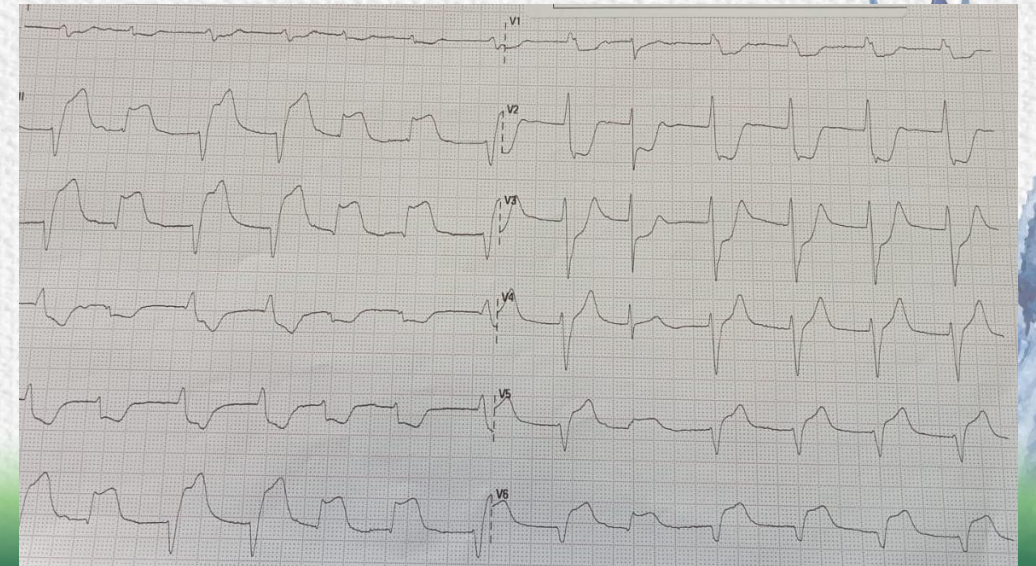
Type 2 diabetes

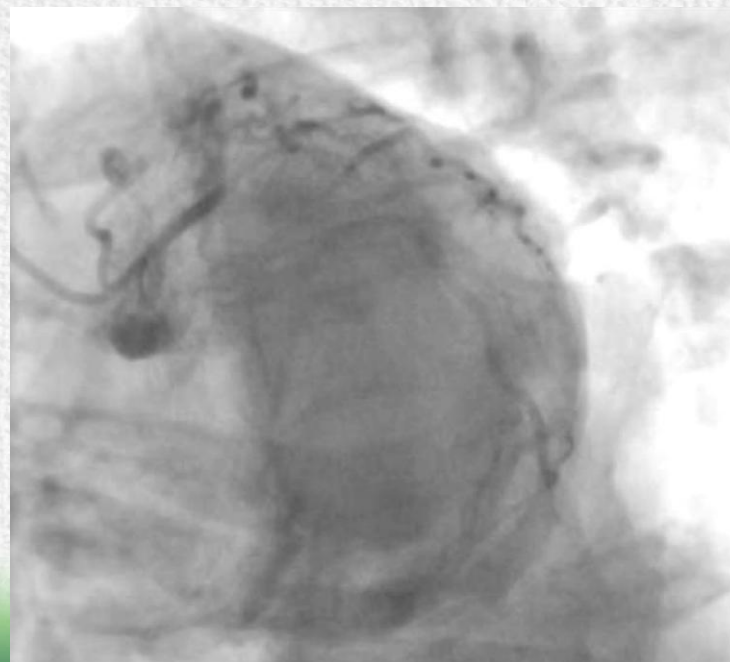
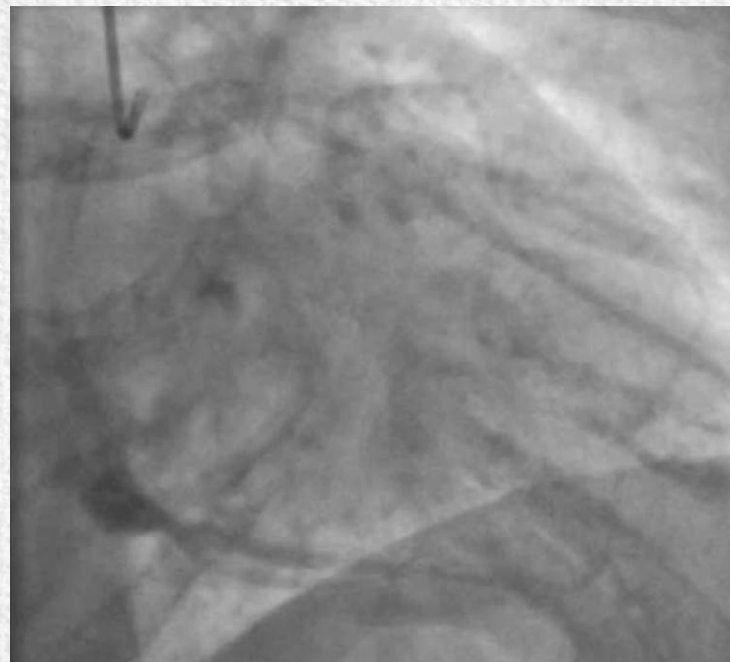
HCV-related liver cirrhosis

Admitted for AMI of 2 hours duration, transferred from the emergency department of another hospital

Upon admission, ST elevation was found on the ECG in the inferior leads

Systolic BP 80 mmHg and hemodynamics were unstable

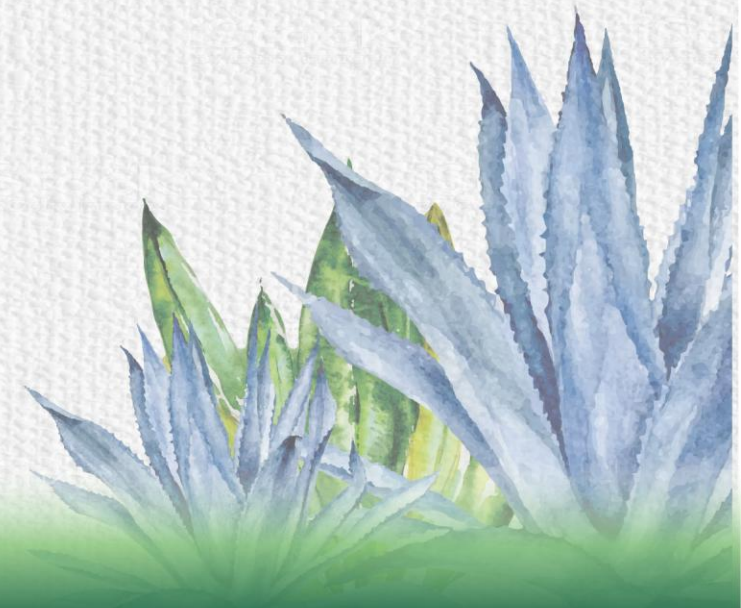




Primary PCI via radial artery.

Implantation of a XIENCE SIERRA 3.0-15 drug-eluting stent after thrombectomy and predilatation with a 3.0-15 balloon.

Intra-aortic balloon counterpulsation support for hemodynamic instability.



Slight improvement. Low-dose vasoactive drugs.

WHAT TO DO WITH THIS BIFURCATED LEFT MAIN

What do the guidelines say?

2022 Joint ESC/EACTS review of the 2018 guideline recommendations on the revascularization of left main coronary artery disease in patients at low surgical risk and anatomy suitable for PCI or CABG

Robert A. Byrne ^{1,2*}, Stephen Femes ^{3,4*}, Davide Capodanno ⁵, Martin Czerny ^{6,7}, Torsten Doenst ⁸, Jonathan R. Emberson ⁹, Volkmar Falk ^{10,11,12,13}, Mario Gaudino ¹⁴, John J. V. McMurray ¹⁵, Roxana Mehran ¹⁶, Milan Milojevic ^{17,18}, and Miguel Sousa Uva ^{19,20}

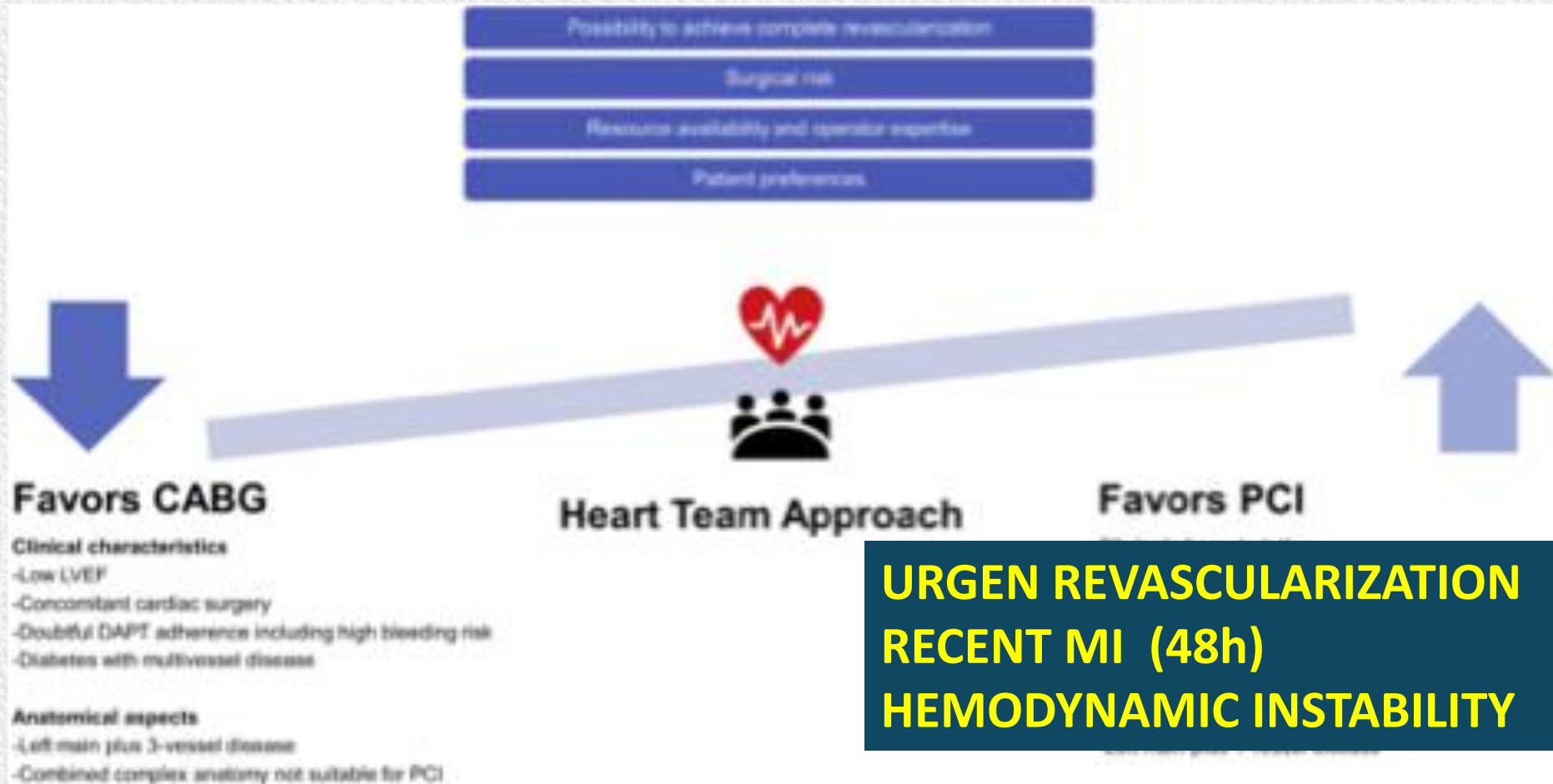
Table 1 Suggested recommendation for type of revascularization in stable patients with left main disease, coronary anatomy suitable for both procedures and low predicted surgical mortality

Recommendation	CABG		PCI	
	Class ^a	Level ^b	Class ^a	Level ^b
Left main disease with low or intermediate SYNTAX score (0–32).	I	A	IIa	A

CABG, coronary artery bypass graft; PCI, percutaneous coronary intervention; SYNTAX, Synergy Between Percutaneous Coronary Intervention with TAXUS and Cardiac Surgery.

^aClass of recommendation.

^bLevel of evidence.



URGEN REVASCULARIZATION
RECENT MI (48h)
HEMODYNAMIC INSTABILITY

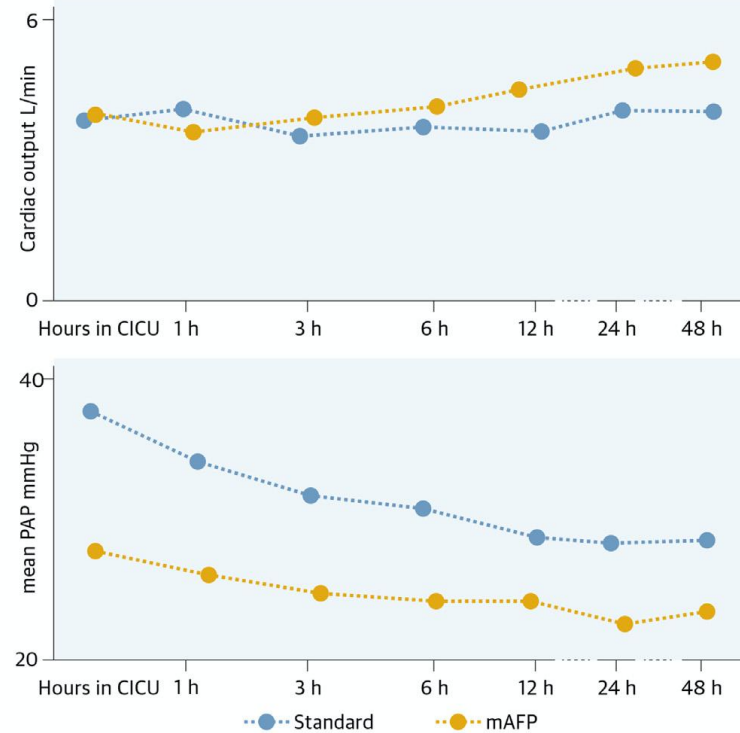
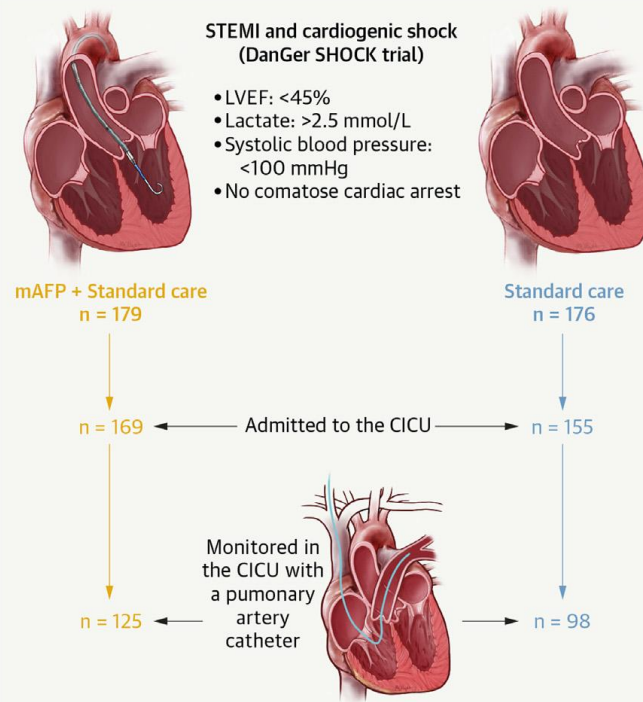


The patient was considered of prohibitive surgical risk and PCI was indicated, which was performed 48 hours later than AMI.

Should any type of circulatory support be used?

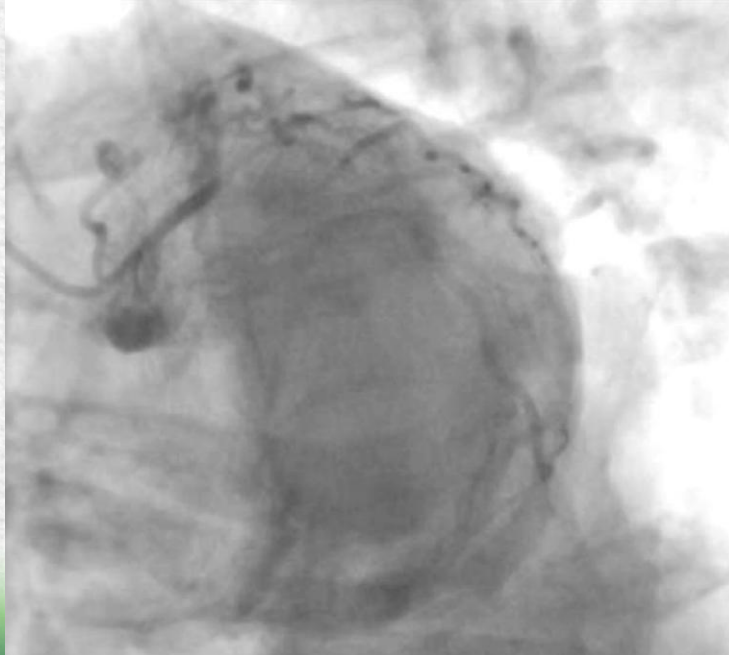
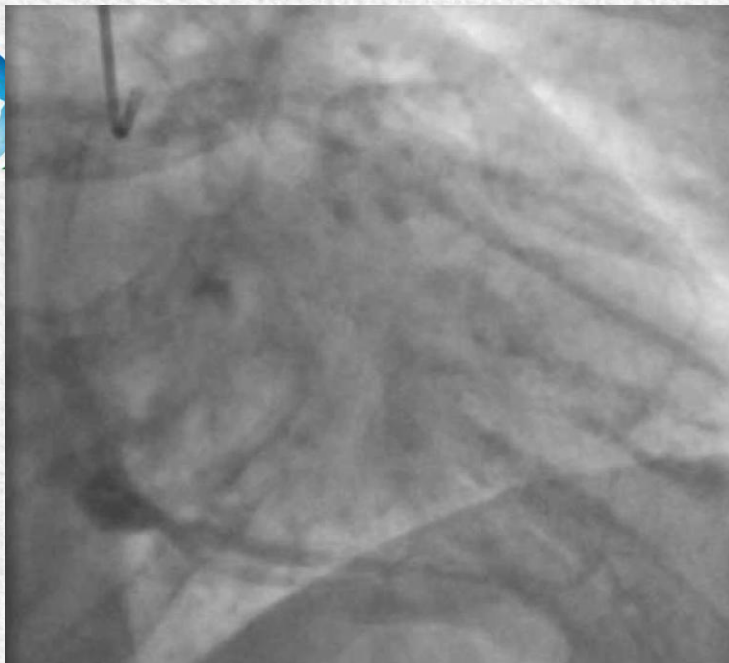
Effect of Microaxial Flow Pump (mAFP) on Hemodynamics in Infarct-Related Cardiogenic Shock in the DanGer SHOCK Randomized Trial

The hemodynamic basis for reduced 180-day all-cause mortality in DanGer SHOCK remain unstudied



CONCLUSION: Using mAFP in STEMI-CS unloads the left ventricle by reducing filling pressure but maintaining and augmenting cardiac output.

(JACC. 2025;85:2456-2468)



The patient was considered of prohibitive surgical risk and PCI was indicated, which was performed 48 hours later than AMI.

Should any type of circulatory support be used?

Left Ventricular Support for Unprotected Left Main Coronary Artery Interventions (The Dayton Heart and Vascular Impella Registry)

Ali Abdul Jabbar^{1,2}, Yaser Jbara¹, Ali J. Ebrahimi², Omar Mufti¹, Omair Ali¹, Ronald Markert¹, David Joffe¹, Gary Fishbein¹

¹Department of Cardiology, Wright State University Boonshoft School of Medicine, Fairborn, Ohio, ²Department of Cardiology, The Heart Institute, Northside Hospital, St. Petersburg, Florida, USA

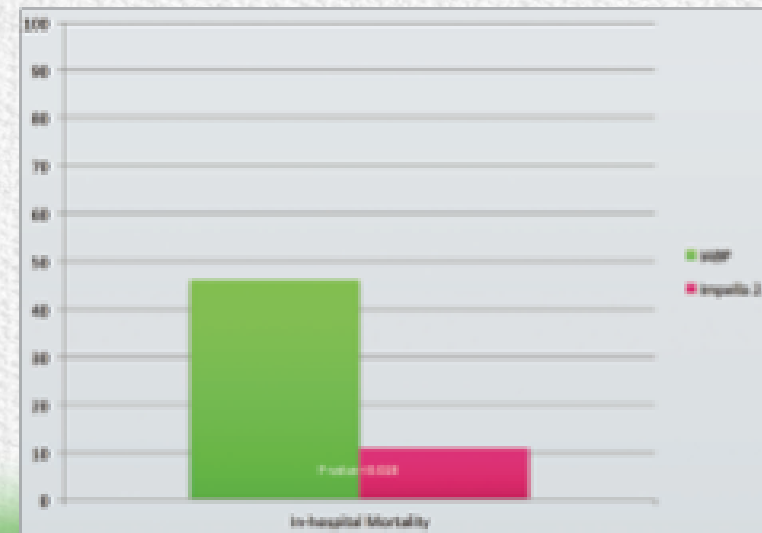
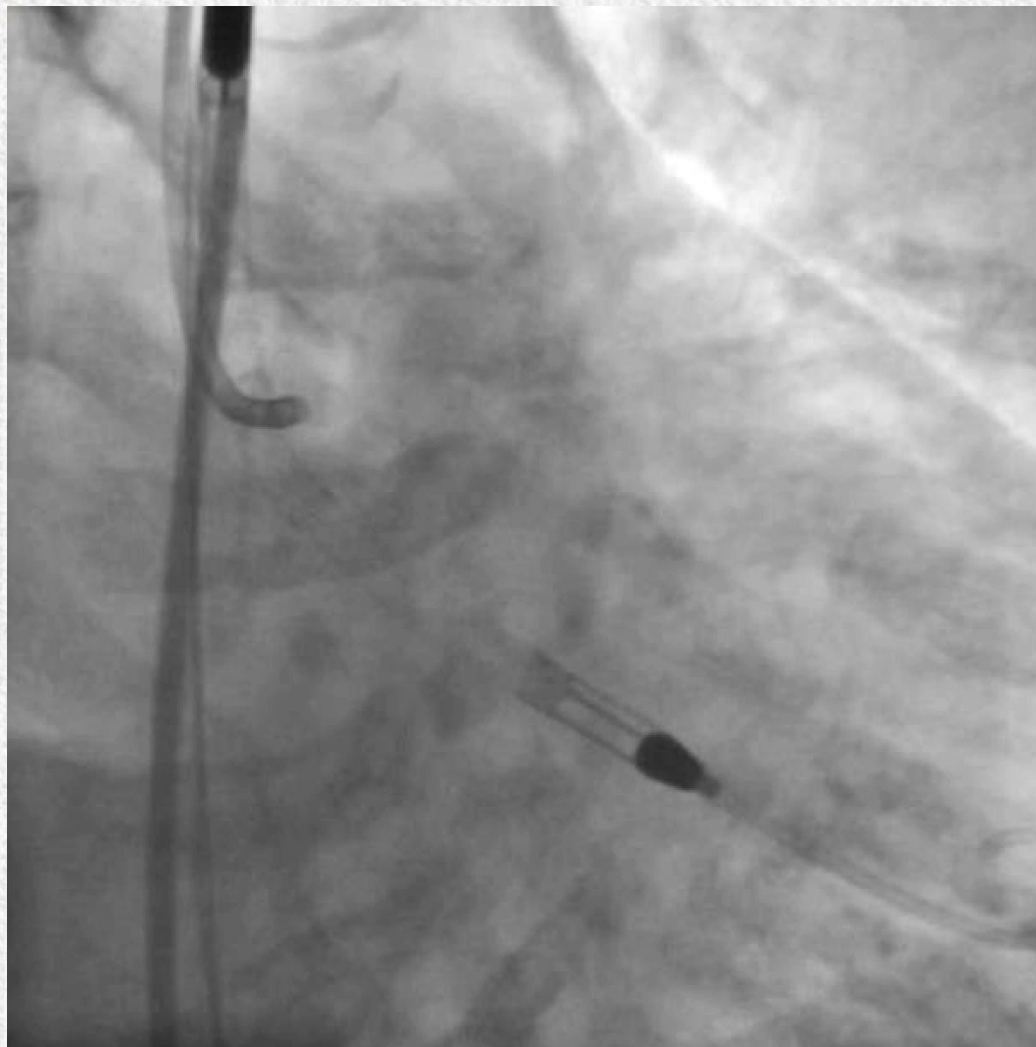


Figure 1: In-hospital mortality and left ventricular support in LM-PCI. LM-PCI: Left main percutaneous coronary intervention



IMPELLA left femoral approach, planned only during PCI. 1 Proglide (pre)

Right femoral PCI . EBU 3.5 7F guiding catheter



Should we perform IVUS to assess the lesion and plan accordingly?

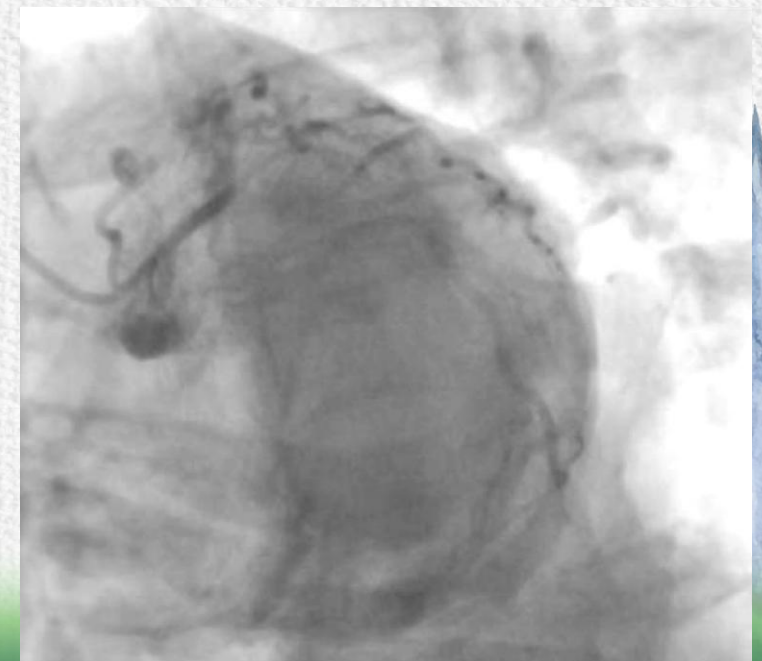
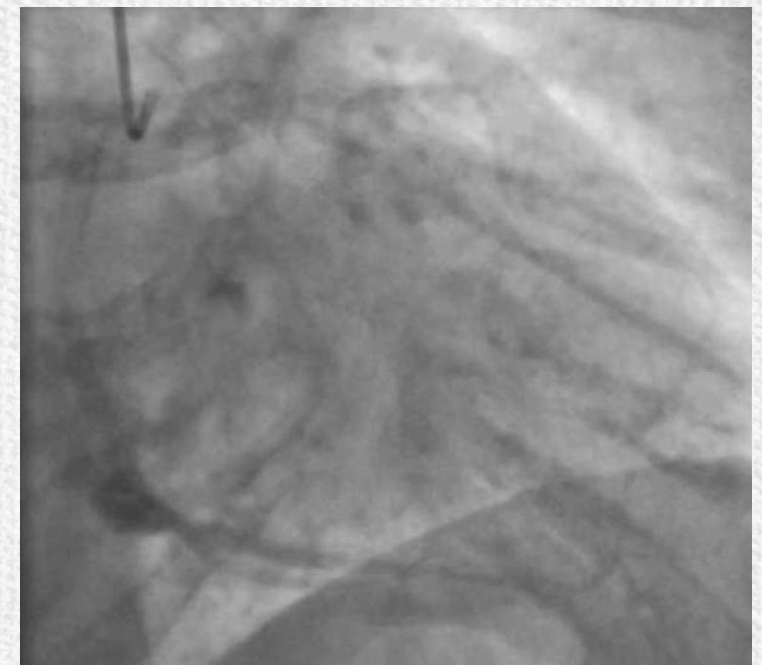
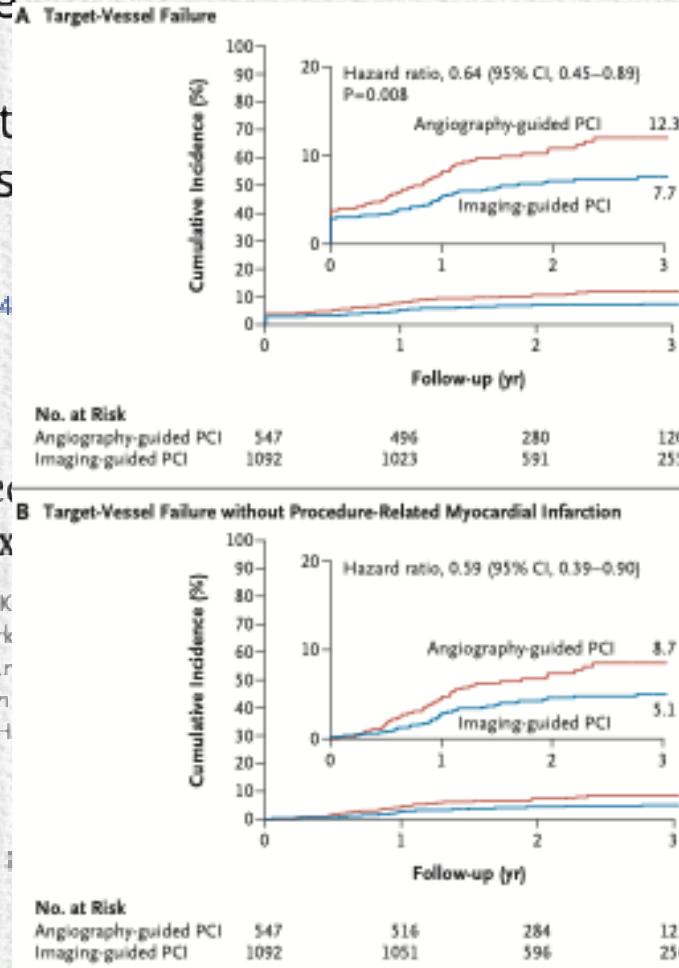
A multi-center, international, randomized, 2-year, parallel-group study to assess the superiority of IVUS-guided PCI versus qualitative angio-guided PCI in unprotected left main coronary artery (ULMCA) diseases
Study protocol for OPTIMAL trial

ClinicalTrials.gov: [NCT04](#)

Intravascular Imaging-Guided or Angiography-Guided Complex

J.M. Lee, K.H. Choi, Y.B. Song, J.-Y. Lee, S.-J. Lee, S.Y. Lee, S.M. K.
J.Y. Cho, C.J. Kim, H.-S. Ahn, C.-W. Nam, H.-J. Yoon, Y.H. Park
J.-O. Jeong, P.S. Song, J.-H. Doh, S.-H. Jo, C.-H. Yoon, M.G. Kar
K.Y. Lee, Y.-H. Lim, Y.-H. Cho, J.-M. Cho, W.J. Jang, K.-J. Chun
T.K. Park, J.H. Yang, S.-H. Choi, H.-C. Gwon, and J.-Y. H.
for the RENOVATE-COMPLEX-PCI Investigators*

N ENGL J MED



3-Year Outcomes of the ULTIMATE Trial Comparing Intravascular Ultrasound Versus Angiography-Guided Drug-Eluting Stent Implantation

Xiao-Fei Gao, MD,^{a,*} Zhen Ge, MD,^{a,*} Xiang-Quan Kong, PhD,^{a,*} Jing Kan, MBBS,^a Leng Han, MD,^b Shu Lu, MD,^c Nai-Liang Tian, MD,^a Song Lin, MD,^a Qing-Hua Lu, MD,^d Xiao-Yan Wang, MD,^e Qi-Hua Li, MD,^f Zhi-Zhong Liu, PhD,^g Yan Chen, MD,^h Xue-Song Qian, MD,^h Juan Wang, MD,^b Da-Yang Chai, MD,^c Chong-Hao Chen, MD,^e Tao Pan, MBBS,^a Fei Ye, MD,^d Jun-Jie Zhang, MD, PhD,^d Shao-Liang Chen, MD, PhD,^a for the ULTIMATE Investigators

The benefit is concentrated in patients who achieved optimal PCI.

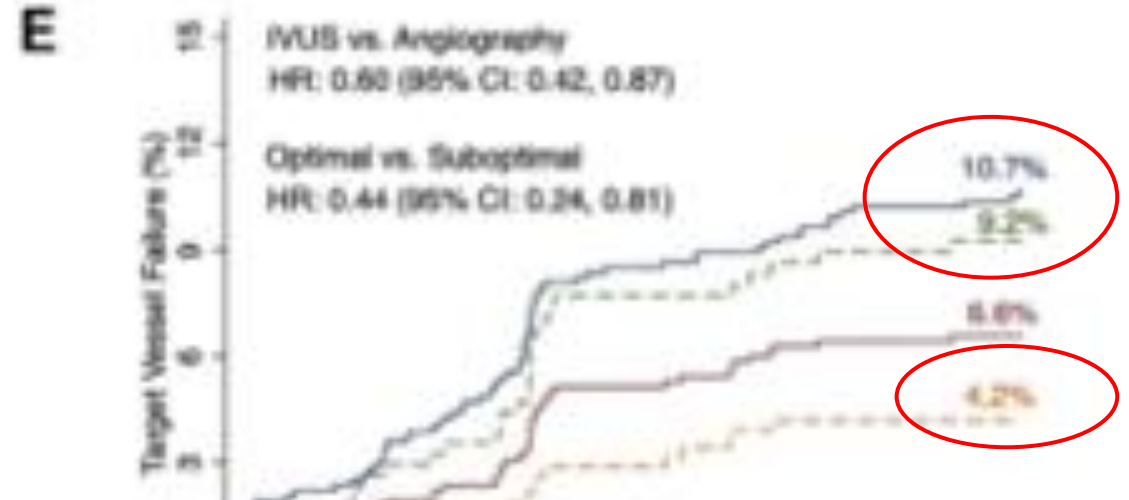
Minimum lumen area of 5 mm² or at least 90% of the distal reference segment.

Plaque burden less than 50% 5 mm proximal and distal to the stent.

No stent edge dissection exceeding 3 mm.

2024 ESC Guidelines for the Management of Chronic Coronary Syndromes

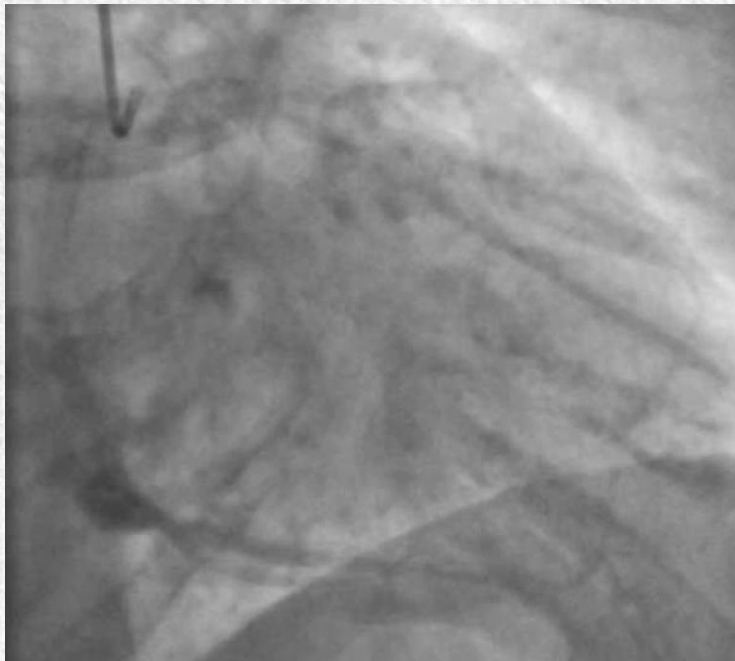
- Intracoronary imaging guidance by **IVUS** or **OCT** is recommended for performing PCI on anatomically complex lesions, in particular **left main stem**, true bifurcations and long lesions.



THE FINAL IVUS (POST STENT) HAS MORE VALUE

Number at risk	0	6	12	18	24	30	36
Angiography guidance	724	696	676	651	643	634	631
IVUS guidance	724	710	696	676	660	655	654
Suboptimal PCI	340	329	320	309	300	296	296
Optimal PCI	384	381	376	367	360	358	358





What technique should be used?

PROVISIONAL STENTING

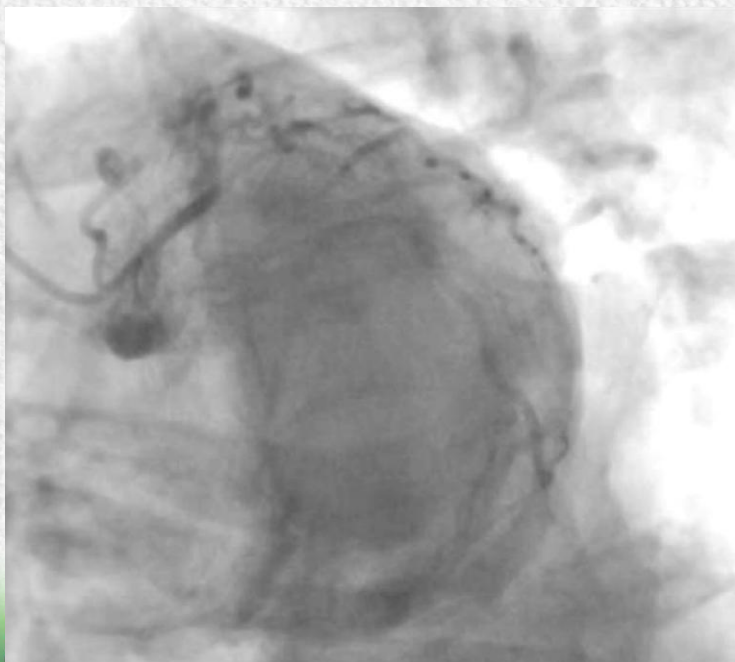
TWO STENTS

PROVISIONAL STENTING (favorable)

No significant side branch injury

Small área of myocardium at risk

Easy to recross



A two-stent technique was decided

The European bifurcation club Left Main Coronary Stent study: a randomized comparison of stepwise provisional vs. systematic dual stenting strategies (EBC MAIN)

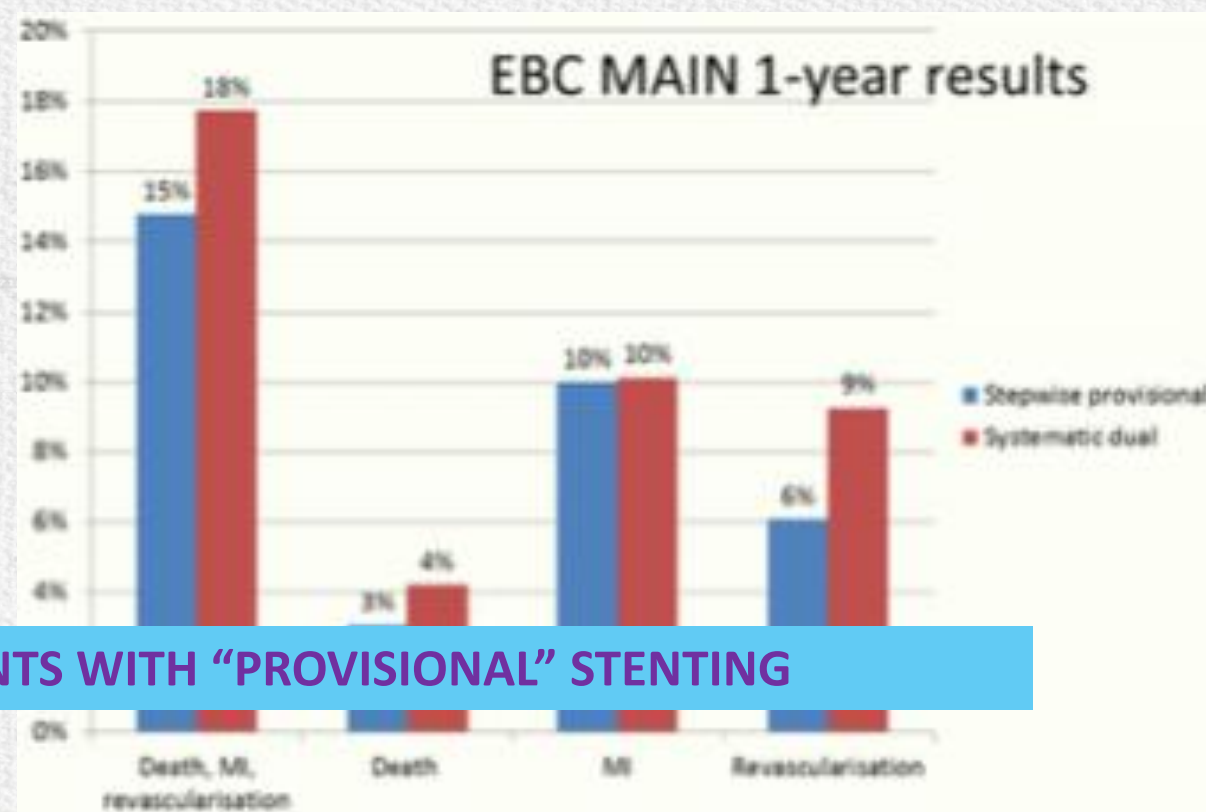
467 patients

True bifurcation 1-1-1 Medina

After kissing, not to treat side branch except:

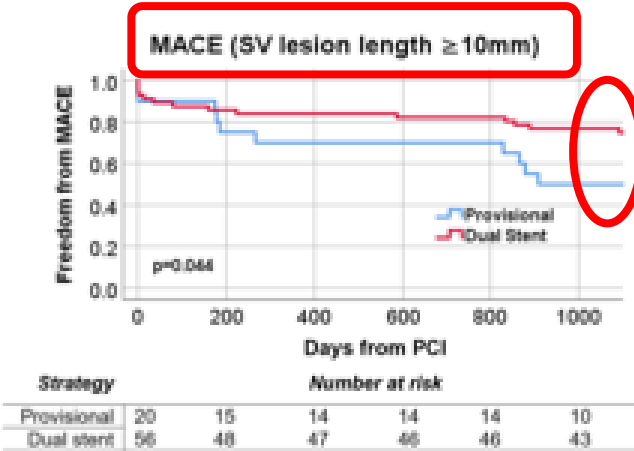
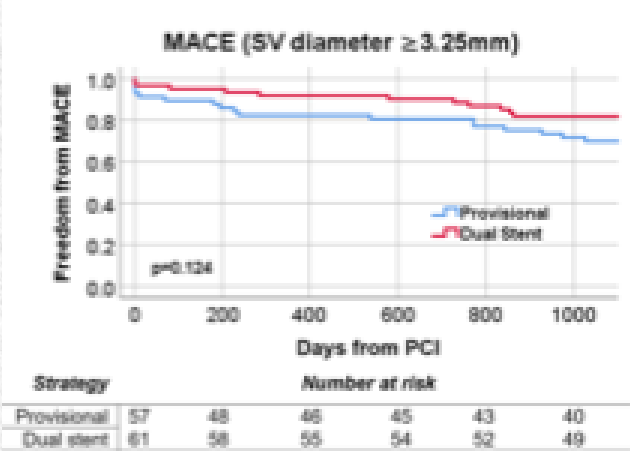
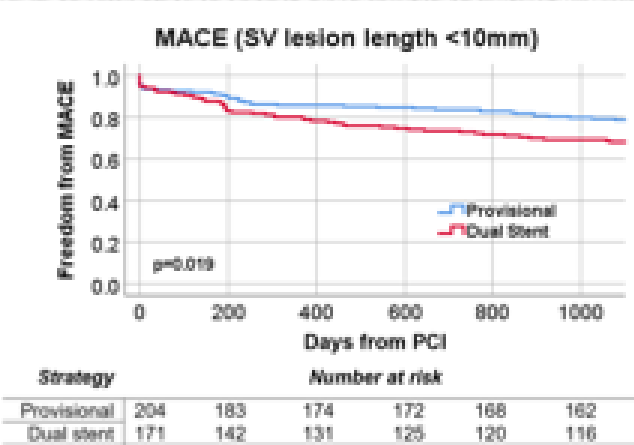
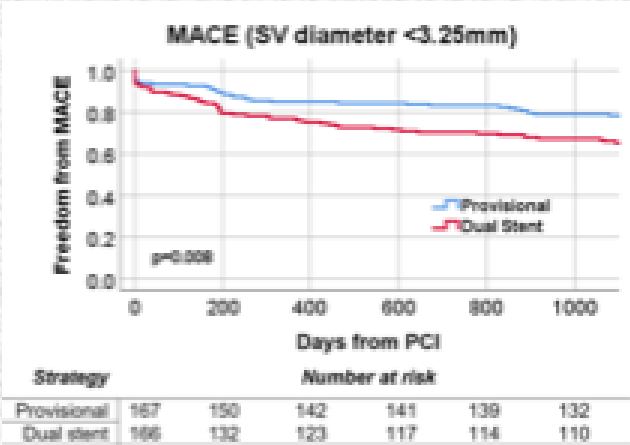
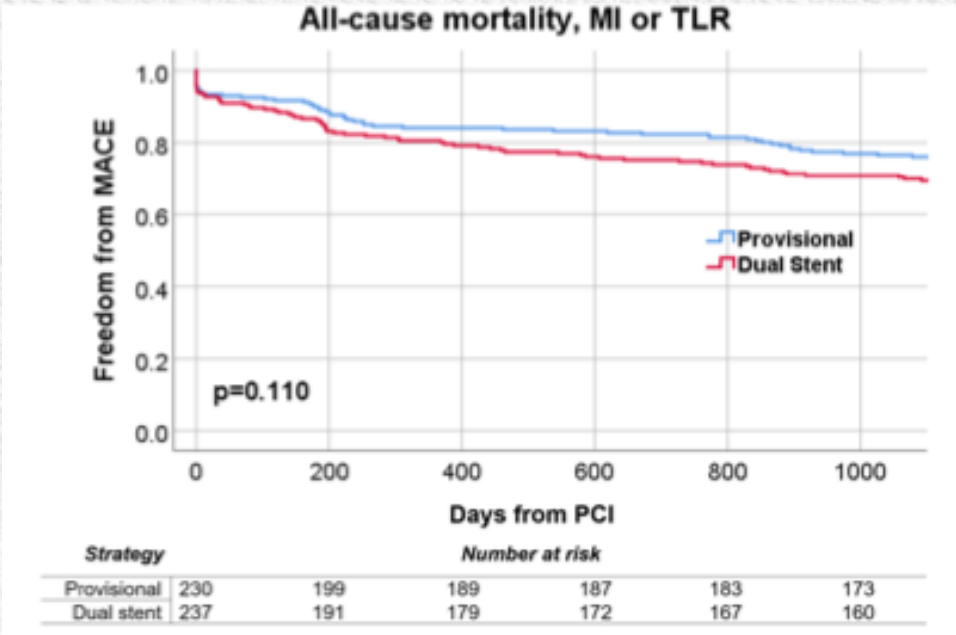
- TIMI non 3
- Dissection > type A
- Threatened occlusion
- Ostial involvement >90%

NON SIGNIFICANT TREND TOWARDS FEWER EVENTS WITH “PROVISIONAL” STENTING

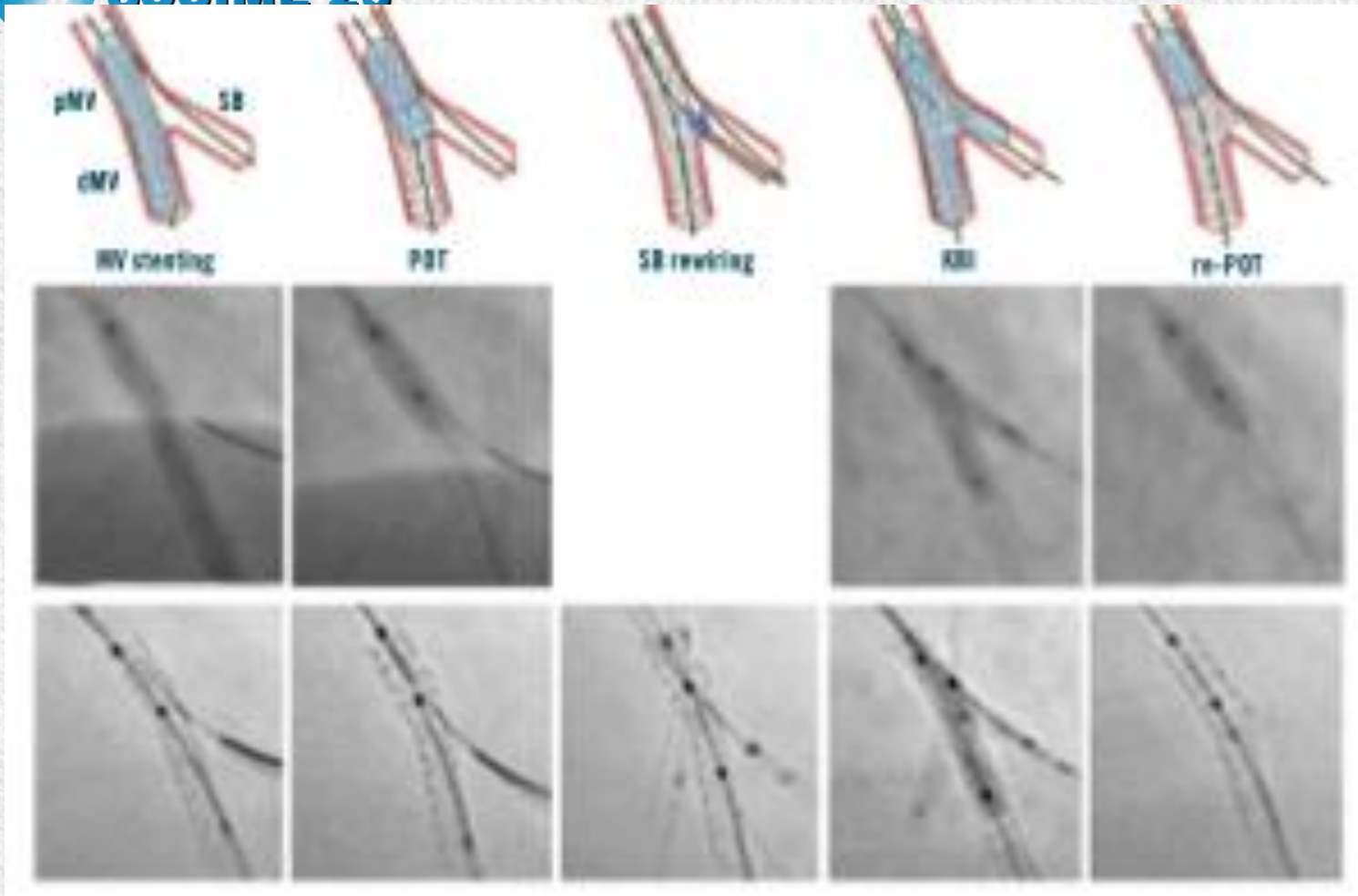


Stepwise Provisional Versus Systematic Dual-Stent Strategies for Treatment of True Left Main Coronary Bifurcation Lesions

3 YEARS FOLLOW UP



WITHOUT DIFFERENCES IN MORTALITY, MI AND TLR



1. Main vessel stenting
adjusted to distal diameter

2. POT from the carina

3. Guidewire crossing to side branch
on distal struts

4. Kissing

5. POT on graft only

Rewiring of the side branch through the distal strut

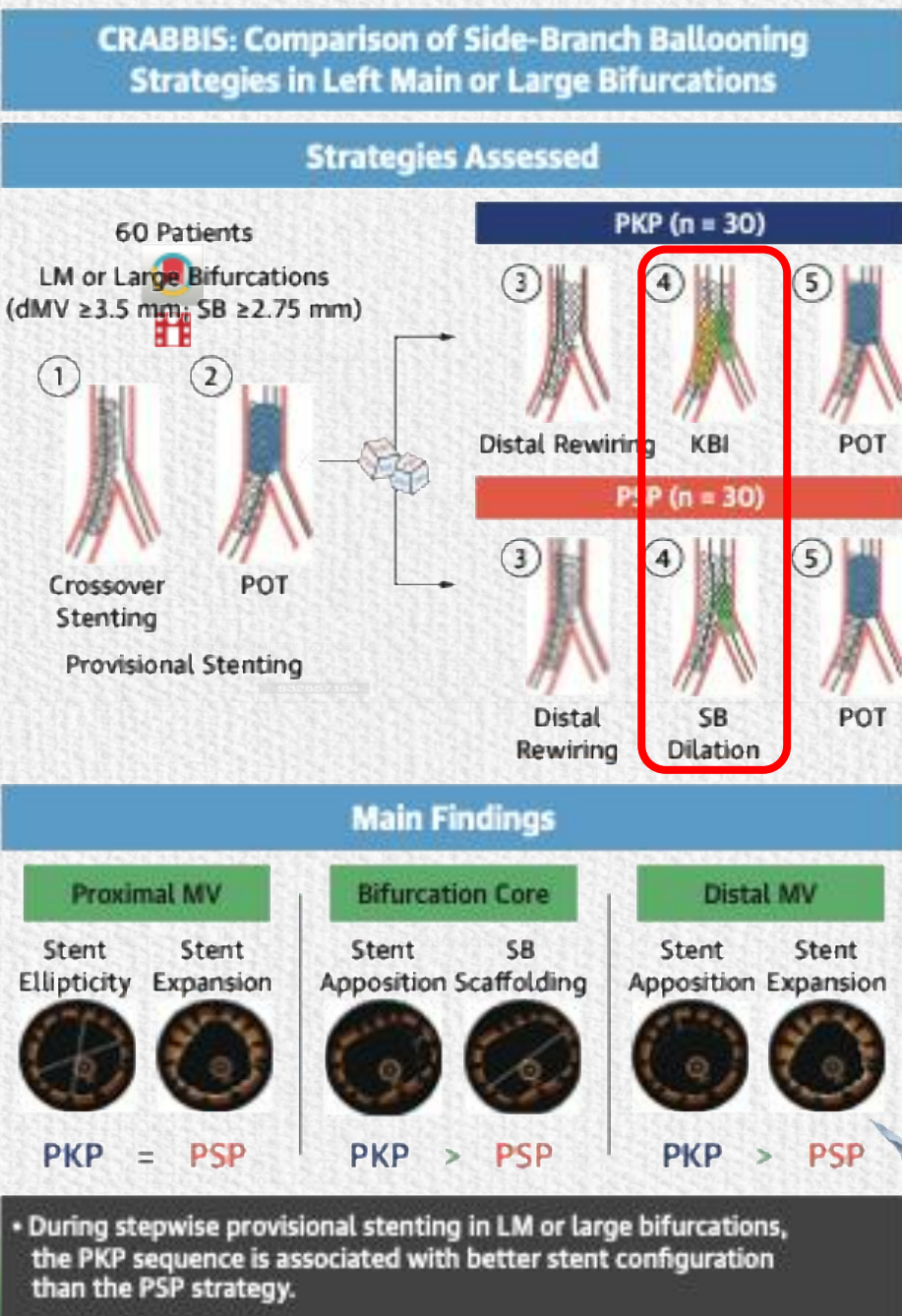
Ideally, this should be confirmed with OCT. Stent enhancement techniques may be an alternative.

Distal advancement to the main branch. Crossing to the side branch pulling back



Comparison of Stent Geometry Achieved by Different Side-Branch Ballooning Techniques For Bifurcation Provisional Stenting

The CRABBIS Trial



LATERAL BRANCH RESULT

Usefulness of other techniques

Is the pressure guiding (FFR) useful?

Are drug coated balloons (DCB) useful?



Improved Outcomes of Combined Main Branch Stenting and Side Branch Drug-Coated Balloon versus Two-Stent Strategy in Patients with Left Main Bifurcation Lesions

Hengdao Liu,¹ Hallong Tao,¹ Xufei Han,¹ Yang Lu,¹ Xiaofei Xue,¹ Ruihan Peng,¹ Fenghua Lv,² Yanwei Liu,³ Hongrui Jin,⁴ Lianjie Li,⁵ and Heping Gu¹

RETROSPECTIVE study

“matched” 100 patients DES +DCB (side branch) vs 2 DES

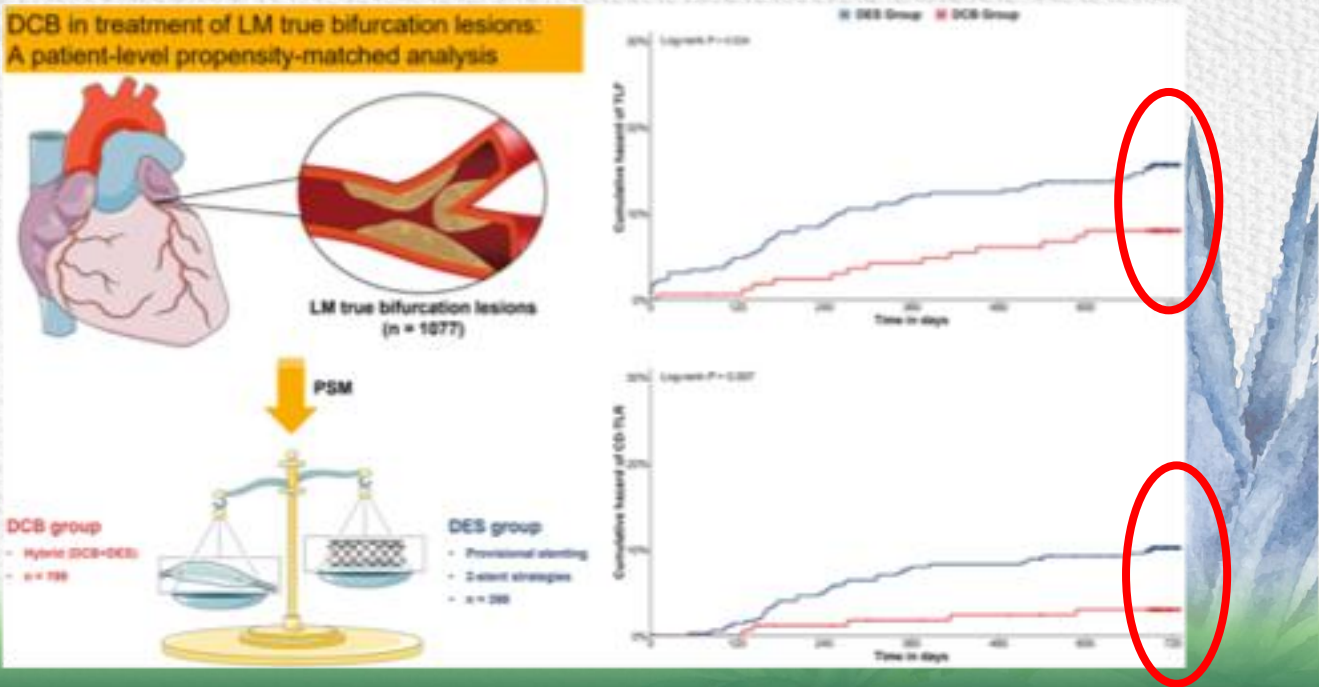
Parameters	2-DES group (n = 23)	DES + DCB group (n = 26)	P value
Left main stem			
MLD (mm, M (P ₂₅ , P ₇₅))	3.31 (2.88, 3.59)	3.23 (3.06, 3.37)	0.530
Luminal stenosis (% M (P ₂₅ , P ₇₅))	14.46 (13.27, 19.46)	13.66 (9.58, 19.73)	0.392
LLL (mm, M (P ₂₅ , P ₇₅))	0.17 (0.10, 0.29)	0.09 (0.03, 0.22)	0.037
Left anterior descending			
MLD [mm, M (P ₂₅ , P ₇₅)]	2.88 (2.51, 3.13)	2.88 (2.62, 3.08)	0.861
Luminal stenosis [% M (P ₂₅ , P ₇₅)]	12.57 (10.60, 17.77)	12.70 (9.83, 20.68)	0.812
LLL [mm, M (P ₂₅ , P ₇₅)]	0.16 (0.09, 0.26)	0.16 (0.03, 0.34)	0.385
Left circumflex			
MLD [mm, M (P ₂₅ , P ₇₅)]	1.80 (1.14, 2.54)	2.41 (2.02, 2.54)	0.031
Luminal stenosis [% M (P ₂₅ , P ₇₅)]	32.09 (18.85, 62.62)	16.71 (9.60, 22.47)	0.002
LLL [mm, M (P ₂₅ , P ₇₅)]	0.43 (0.21, 1.59)	-0.17 (-0.31, 0.08)	<0.001
Restenosis [case (%)]			
Left main stem	1 (4.3)	2 (7.7)	1.000*
Left anterior descending branch	1 (4.3)	2 (7.7)	1.000*
Left circumflex	7 (30.4)	2 (7.7)	0.093*

Without differences in MACE (1 year)

Drug-coated balloon in the treatment of coronary left main true bifurcation lesion: A patient-level propensity-matched analysis

Liang Pan^{1†}, Wenjie Lu^{2†}, Zhanying Han¹, Sancong Pan², Xi Wang¹, Yingguang Shan¹, Meng Peng¹, Xiaofei Qin¹, Guoju Sun¹, Peisheng Zhang³, Jianzeng Dong^{1*} and Chunguang Qiu^{1*}

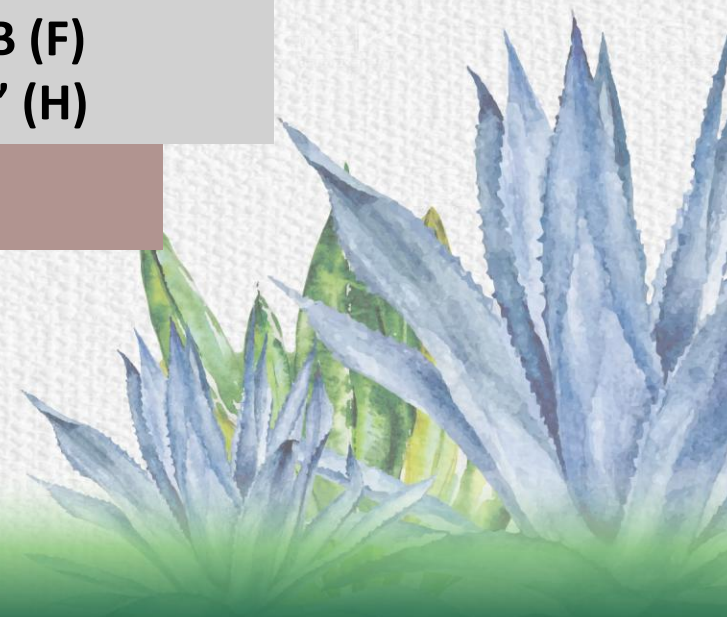
1077 eligible patients : propensity “score”
199 DCB side branch 398 (2 DES o provisional)



TÉCNICA CON EL BALÓN DE DROGAS



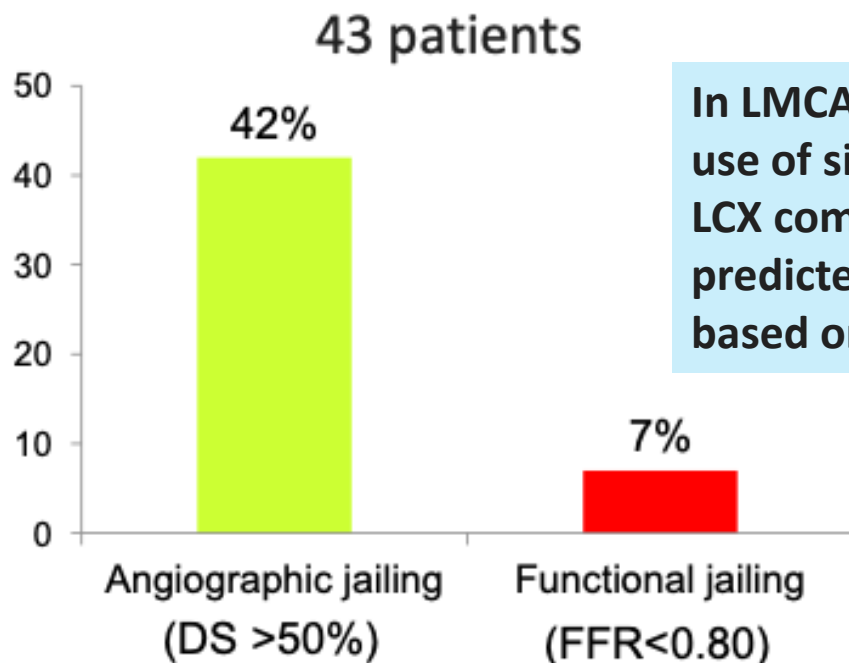
**PLAQUE PREPARATION (E) before DEB (F)
AND AFTER “KISSING” (G) AND “POT” (H)**



FFR IN SIDE BRANCH

Functional and morphological assessment of side branch after left main coronary artery bifurcation stenting with cross-over technique

Functionally Significant LCX Jailing After Stent Crossover (LCX ostial DS<50%)



In LMCA bifurcation lesions with mild LCX ostial disease, the use of single-stent technique rarely resulted in the functional LCX compromise. Because the functional LCX stenosis is poorly predicted by a small MLA, sidebranch treatment should be based on the poststenting FFR

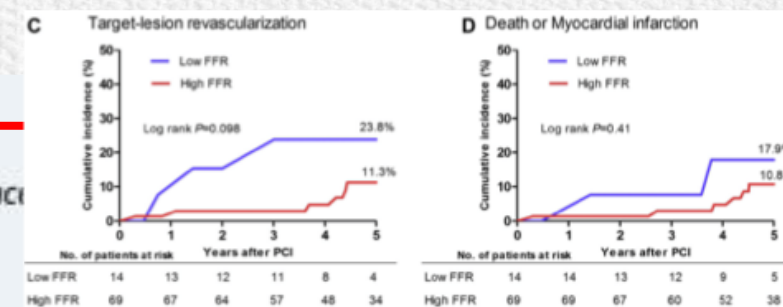
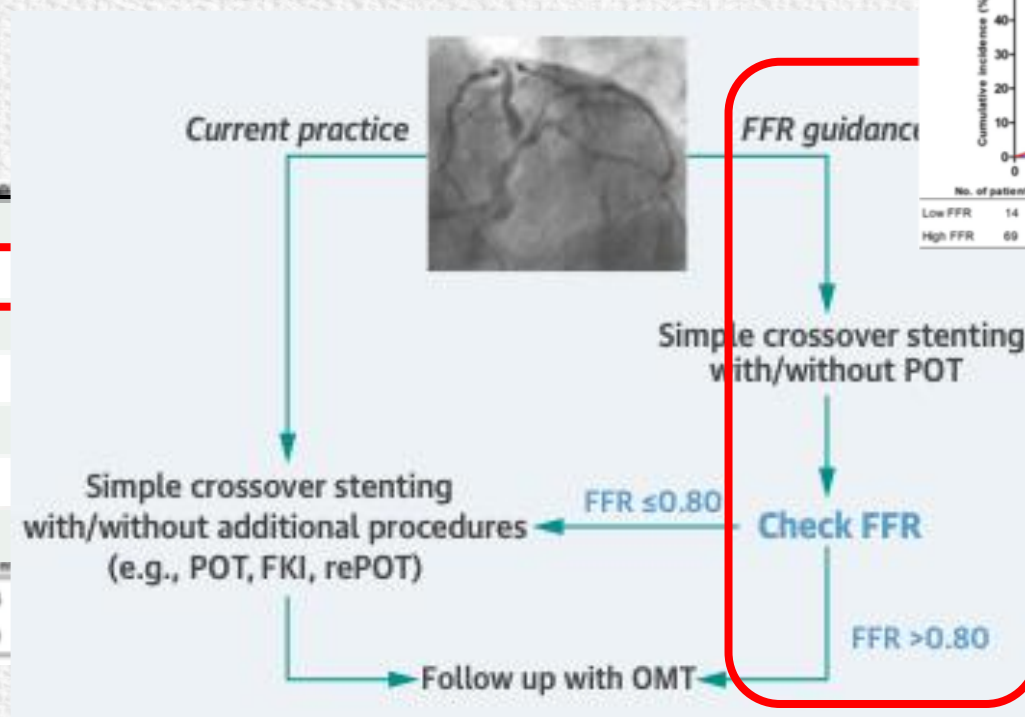
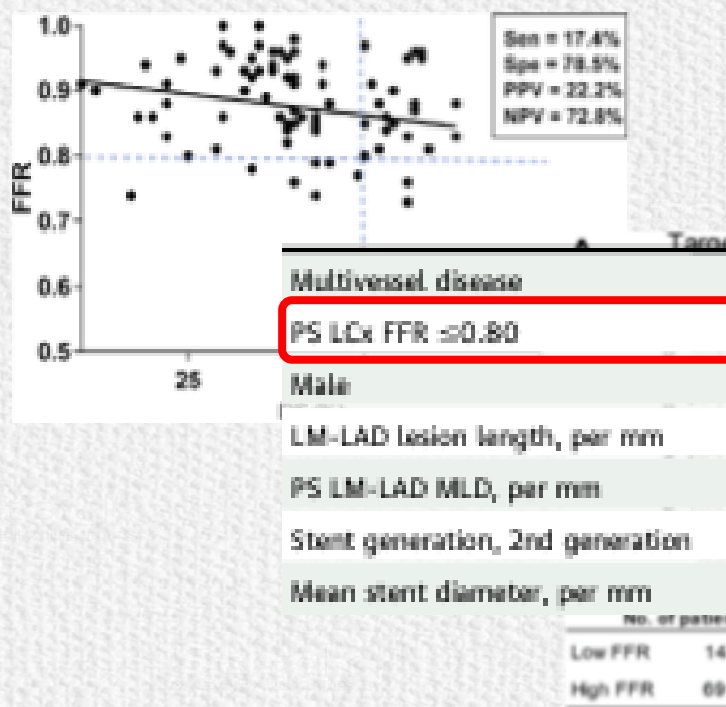
- Sensitivity of 100%
- Specificity of 65%
- PPV of 14%
- NPV of 100%

Kang SJ, Catheterization and Cardiovascular Interventions. 2014;83(4):545-52.

5-Year Outcomes According to FFR of Left Circumflex Coronary Artery After Left Main Crossover Stenting

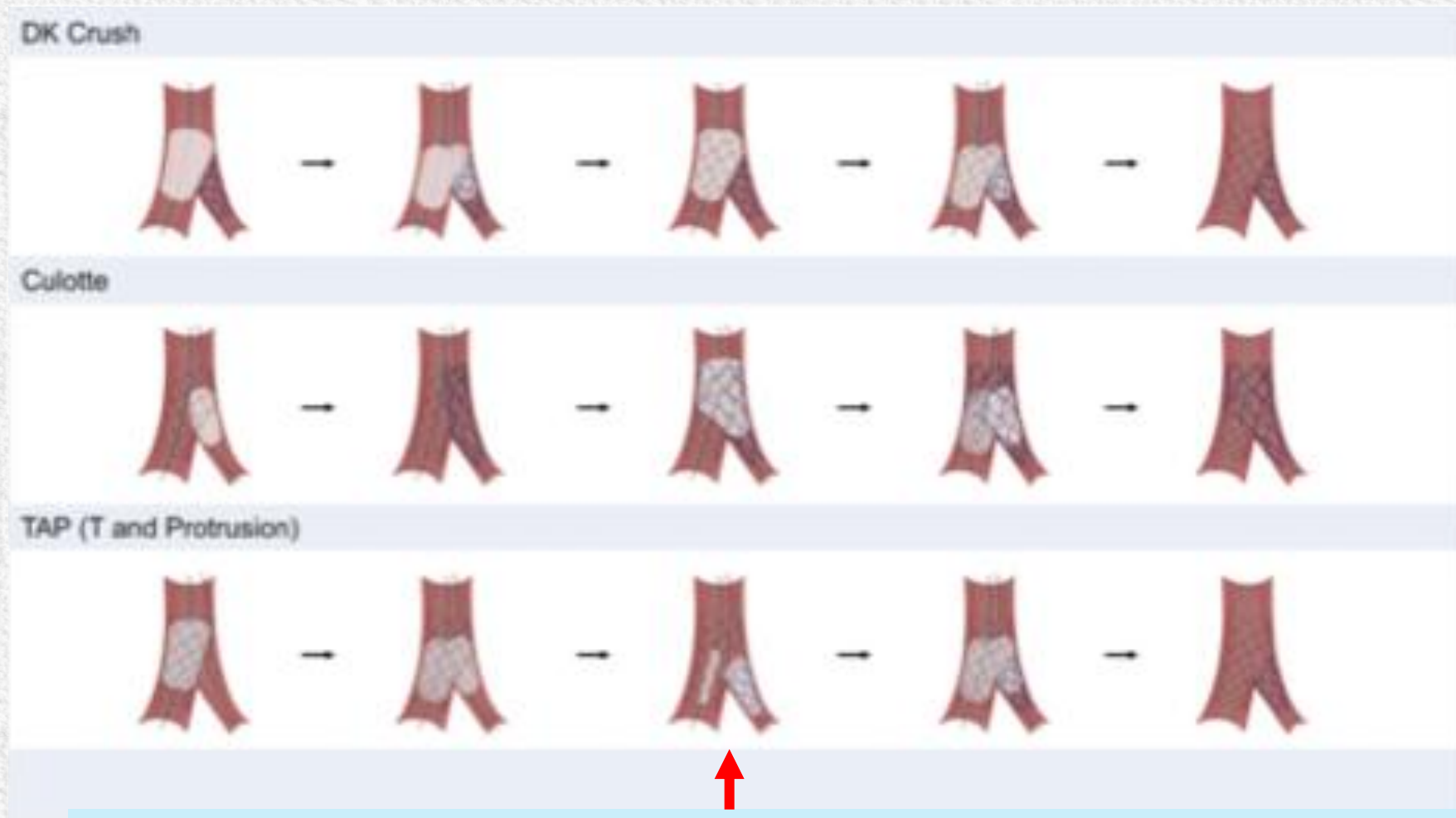
Cheol Hyun Lee, MD,^a Sang-Woong Choi, MD,^a Jongmin Hwang, MD,^a In-Cheol Kim, MD,^a Yun-Kyeong Cho, MD,^a Hyoung-Seob Park, MD,^a Hyuck-Jun Yoon, MD,^a Hyungseop Kim, MD,^a Seongwook Han, MD,^a Jin Young Kim, MD,^b Joo Myung Lee, MD,^c Joon-Hyung Doh, MD,^d Eun-Seok Shin, MD,^e Bon-Kwon Koo, MD,^f Seung-Ho Hur, MD,^g Chang-Wook Nam, MD^a

83 patients
5 years follow up



0.018
0.013
0.025
0.035

WHAT DID WE DO IN OUR CASE?



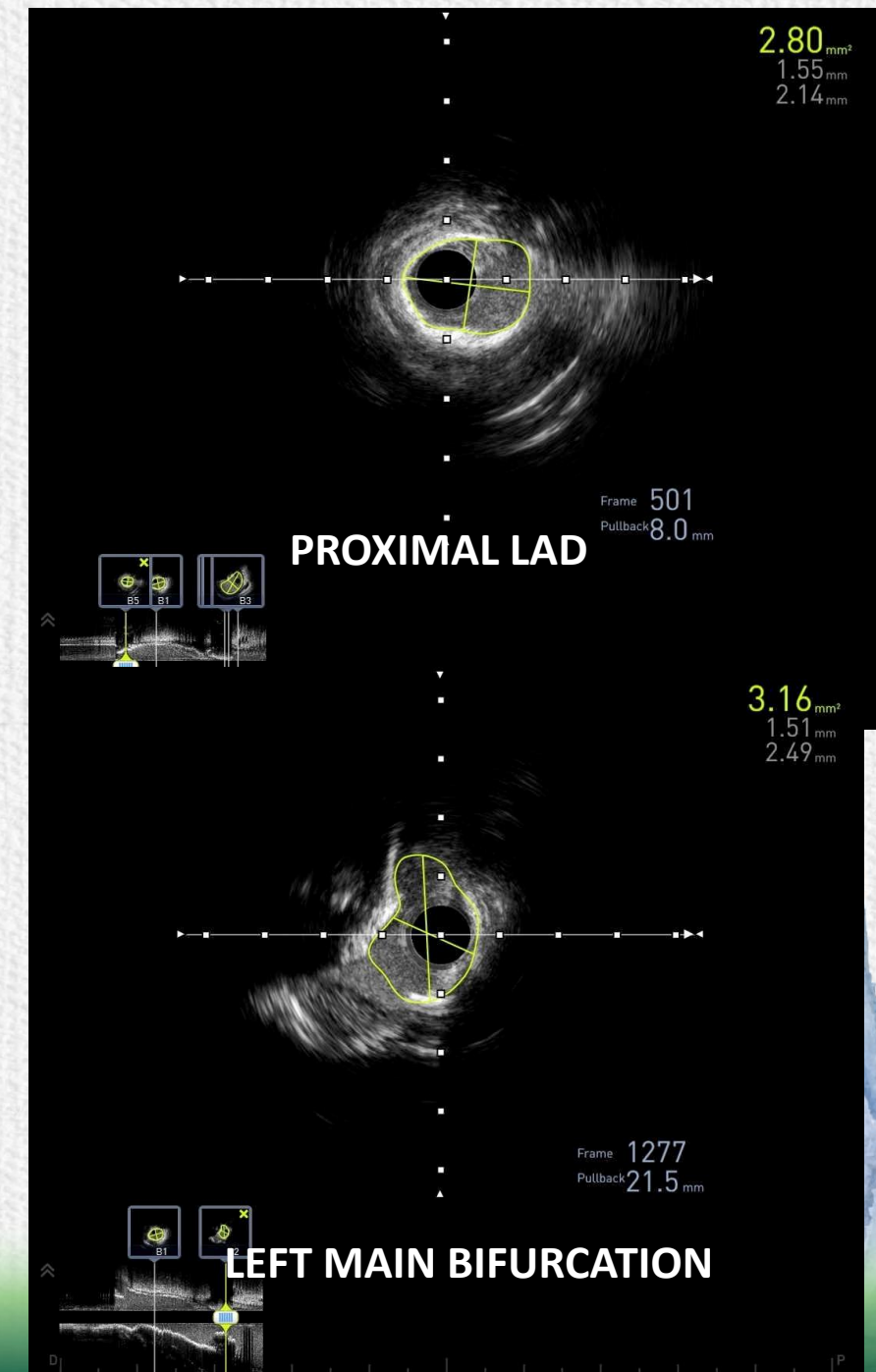
“T” : RESERVED FOR ANGULATIONS OF THE LATERAL BRANCH CLOSE TO 90º

WHAT DID WE DO IN OUR CASE?



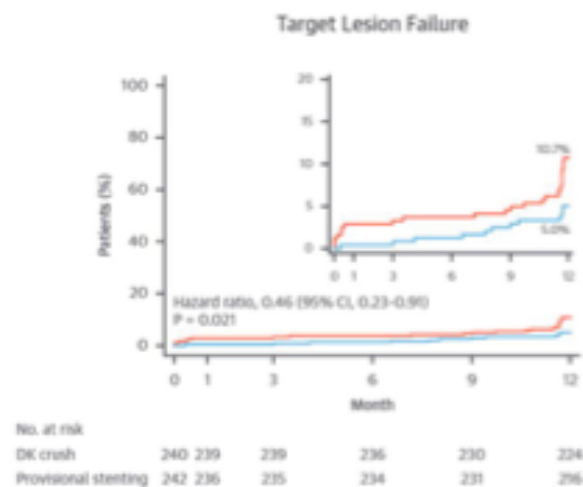
DK CRUSH

- 1.- "KISSING" WITH NC BALLOONS 2.75-15 (LAD) y 2.5-15 (LCX)
- 2.- IVUS
- 3.- Circumferential calcium in LAD: Shockwave 3.0-12

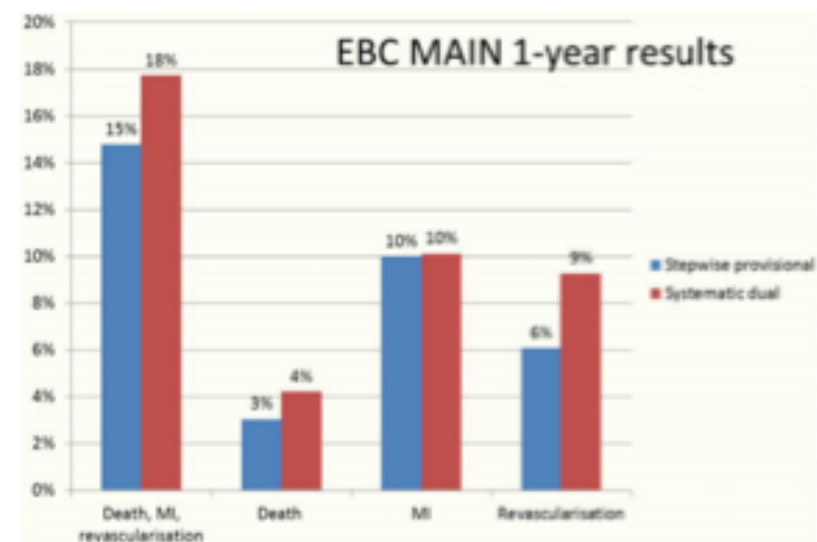


RANDOMIZED TRIALS FOR TRUE BIFURCATIONS

DK-CRUSH V Trial favored DK-CRUSH



EBC-MAIN Trial favored One-Stenting

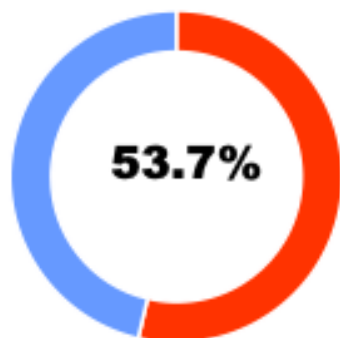


TWO STENTS : 47% IN "PROVISIONAL" GROUP

TWO STENTS : 22% IN "PROVISIONAL" GROUP

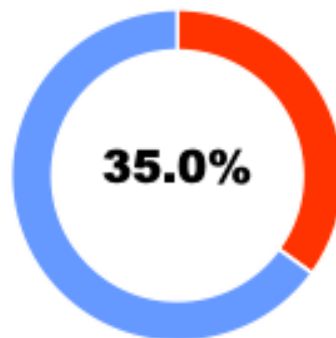
Two Stent Technique in Randomized Trials

PRECOMBAT Trial



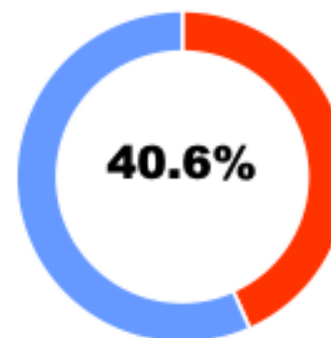
Crush Technique

EXCEL Trial



T Stenting

NOBLE Trial



Culotte

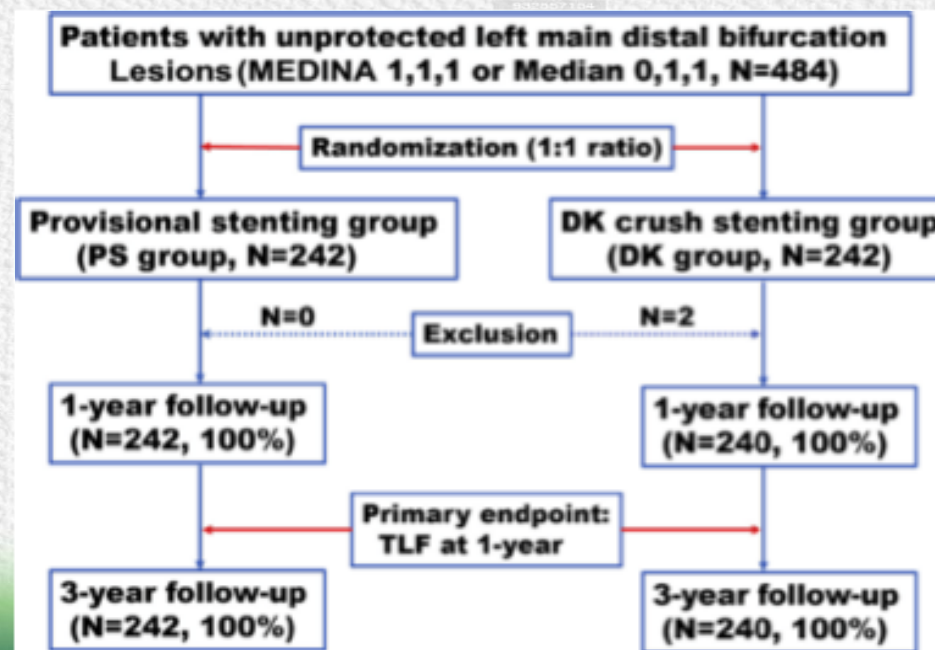
Why DK CRUSH?

Once a side branch stenting is chosen based on the severity and length of the lesion, the myocardium at risk, the likelihood of a successful outcome with the balloon, and the ease of converting to two stents, etc.

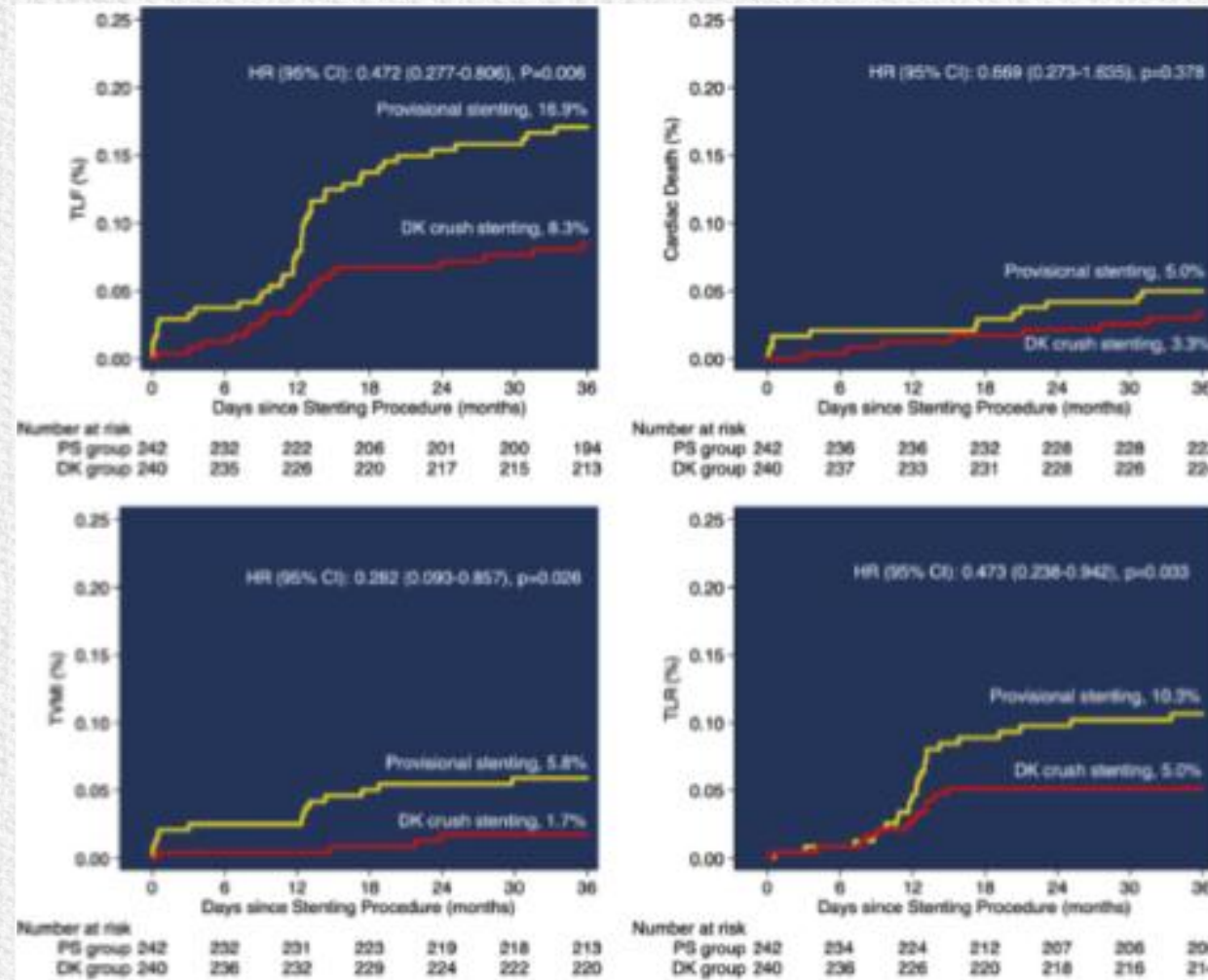
3-Year Outcomes of the DKCRUSH-V Trial Comparing DK Crush With Provisional Stenting for Left Main Bifurcation Lesions



Xiang Chen, MD,^{a,*} Xiaobo Li, MD,^{a,*} Jun-Jie Zhang, PhD,^{a,*} Yaling Han, MD,^b Jing Kan, MBBS,^a Lianglong Chen, MD,^c Chunguang Qiu, MD,^d Teguh Santoso, MD,^e Chootopol Paiboon, MD,^f Tak W. Kwan, MD,^g Imad Sheiban, MD,^h Martin B. Leon, MD,ⁱ Gregg W. Stone, MD,^j Shao-Liang Chen, MD,^{a,j} for the DKCRUSH-V Investigators



3-Year Outcomes of the DKCRUSH-V Trial Comparing DK Crush With Provisional Stenting for Left Main Bifurcation Lesions



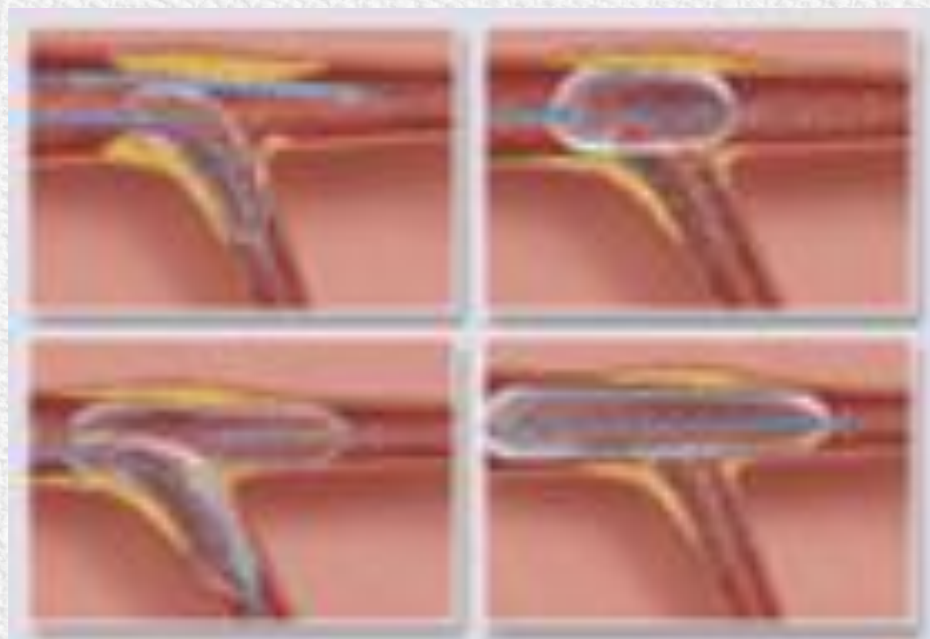
3 years follow up: Less TLR, TLF and MI than “provisional” technique

DK CRUSH TECHNIQUE

SIDE BRANCH STENTING

FIRST "KISSING"

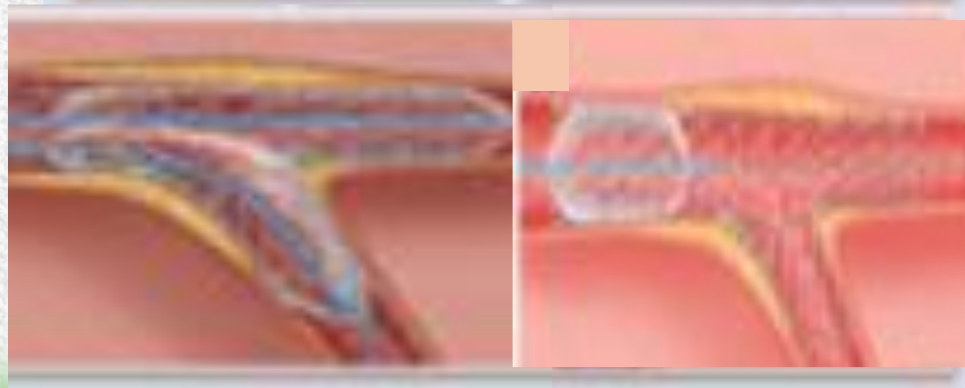
Advance guidewire proximal on the side branch



BALLOON (pre advanced to LAD) on Left main-LAD ("crushing" CX stent)

STENT ON LEFT MAIN-LAD

Second "KISSING"



POT



Why DK CRUSH?

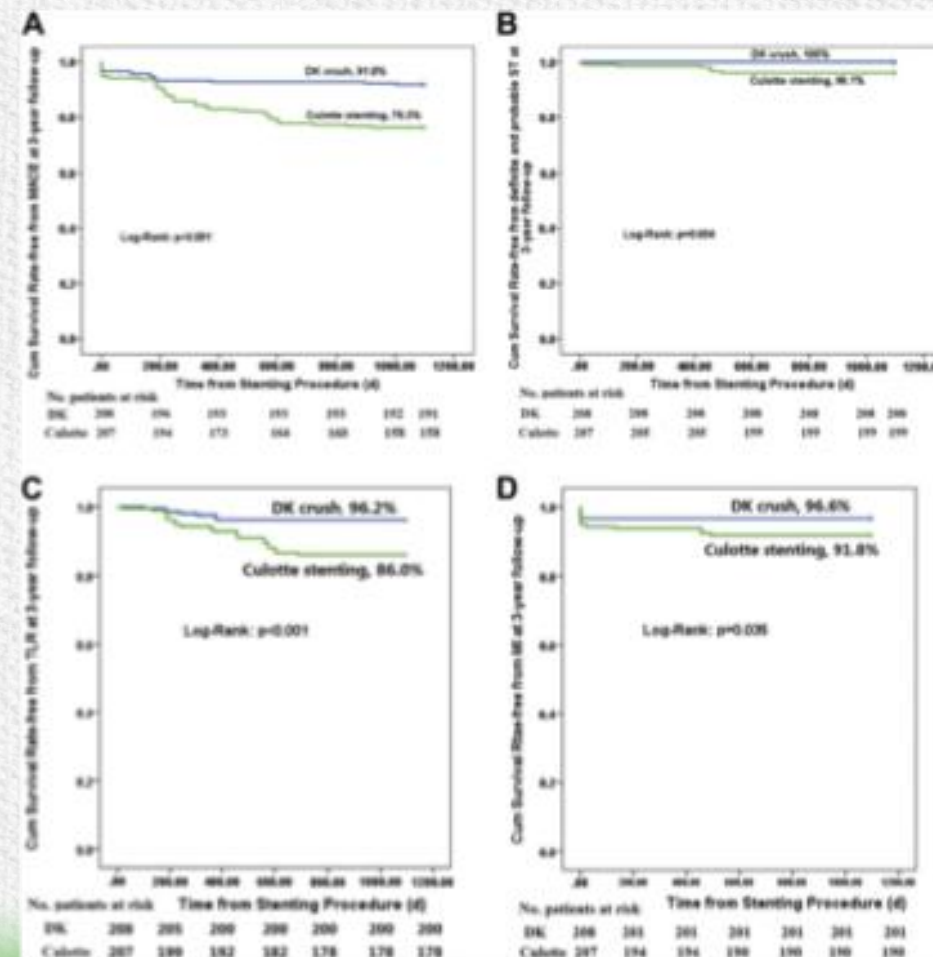
Once a side branch stenting is chosen based on the severity and length of the lesion, the myocardium at risk, the likelihood of a successful outcome with the balloon, and the ease of converting to two stents, etc.

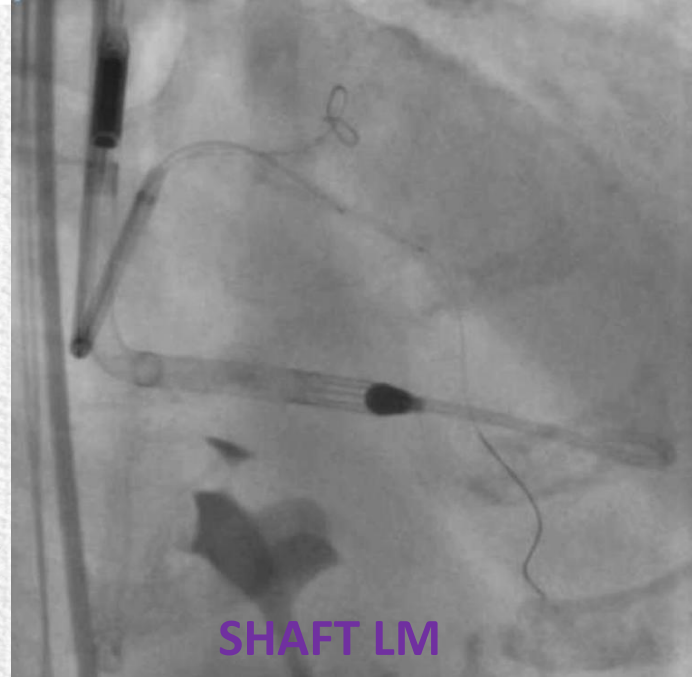
Clinical Outcome After DK Crush Versus Culotte Stenting of Distal Left Main Bifurcation Lesions

The 3-Year Follow-Up Results of the DKCRUSH-III Study

Shao-Liang Chen, MD,* Bo Xu, MBBS,† Ya-Ling Han, MD,‡ Imad Sheiban, MD,§ Jun-Jie Zhang, MD,* Fei Ye, MD,* Tak W. Kwan, MD,|| Chitprapai Pailboon, MD,¶ Yu-Jie Zhou, MD,* Shu-Zheng Lv, MD,* George D. Dangas, MD,** Ya-Wei Xu, MD,†† Shang-Yu Wen, MD,‡‡ Lang Hong, MD,§§ Rui-Yan Zhang, MD,||| Hai-Chang Wang, MD,¶¶ Tie-Ming Jiang, MD,## Yan Wang, MD,*** Teguh Sansoto, MD,††† Fang Chen, MD,* Zu-Yi Yuan, MD,‡‡‡ Wei-Min Li, MD,§§§ Martin B. Leon, MD||||

419 randomized patients: DK CRUSH vs CULOTTE
3 years follow up

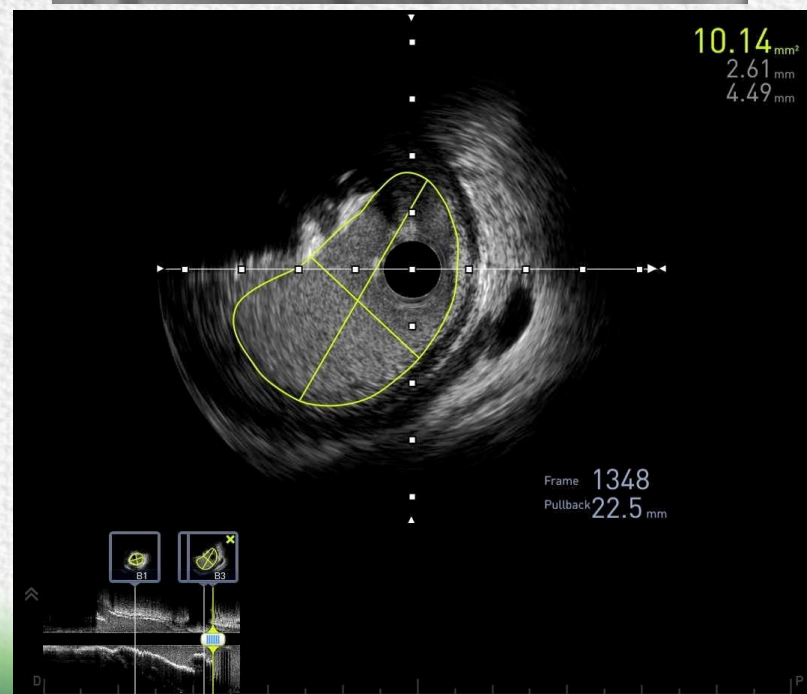
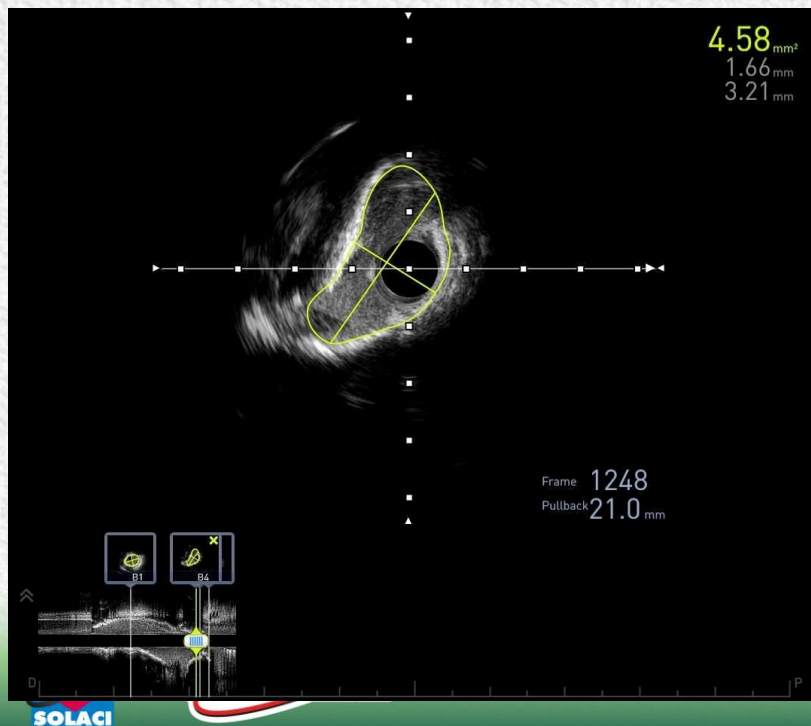


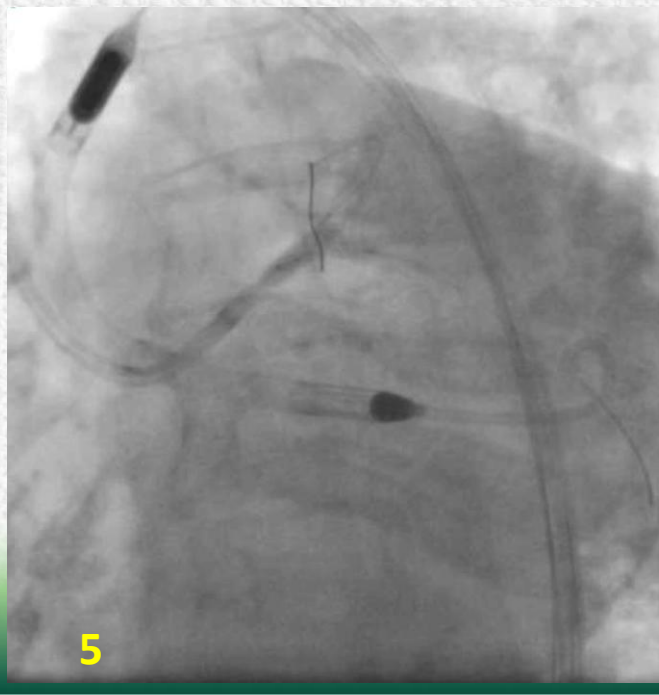
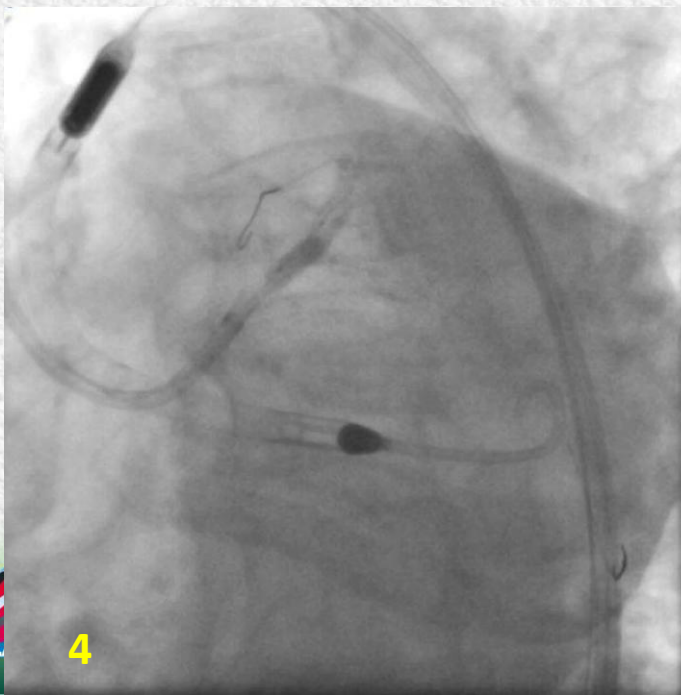
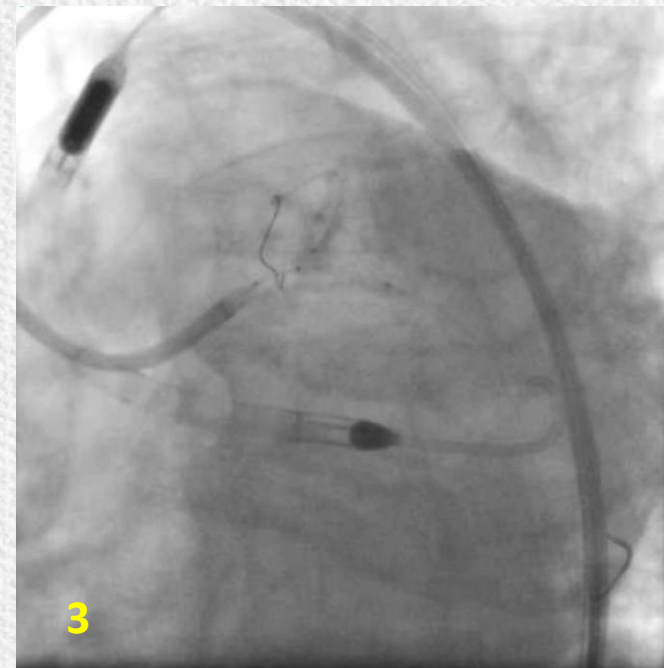
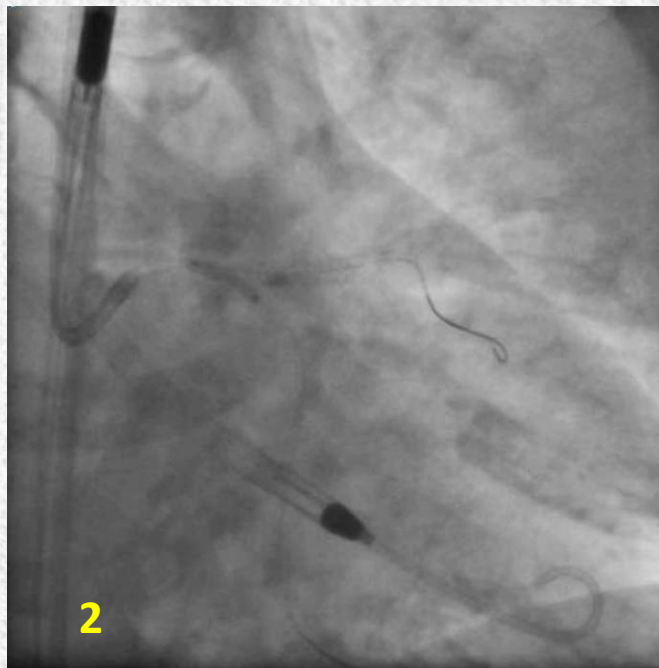


DISTAL LM

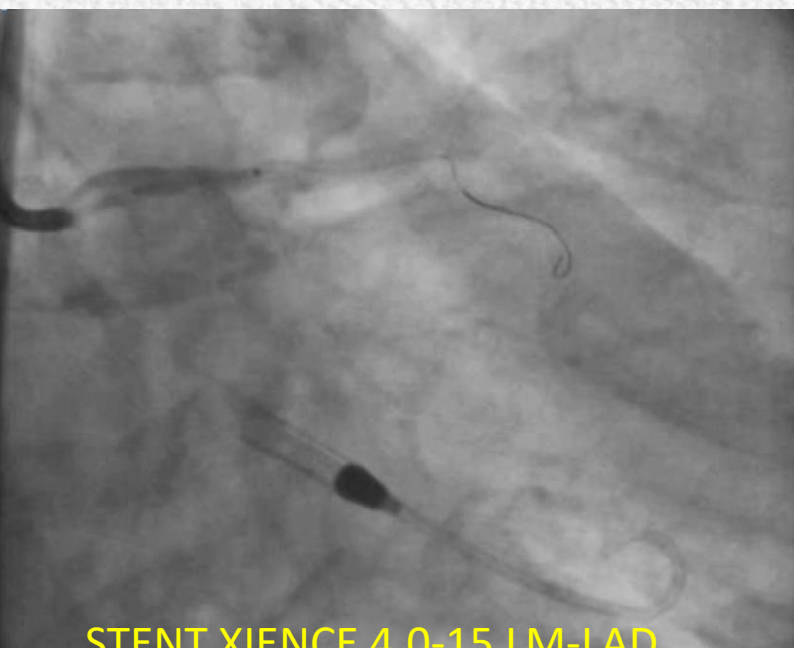
SHAFT LM

PROXIMAL. LM





- 1. XIENCE 3.0-18 proximal LAD stent
- 2. NC balloon dilation 2.5-12 ostial LCX
- 3. SYNERGY 2.5-12 ostial LCX stent
- 4. 3.5-15 left main-LAD balloon
- 5. First kissing 3.5-15 LAD, 2.5-15 LCX



STENT XIENCE 4.0-15 LM-LAD



"KISSING" 3.5-15 LAD 2.75-15 LCX
Proximal "rewiring"



POT balloon NC 4.5-6

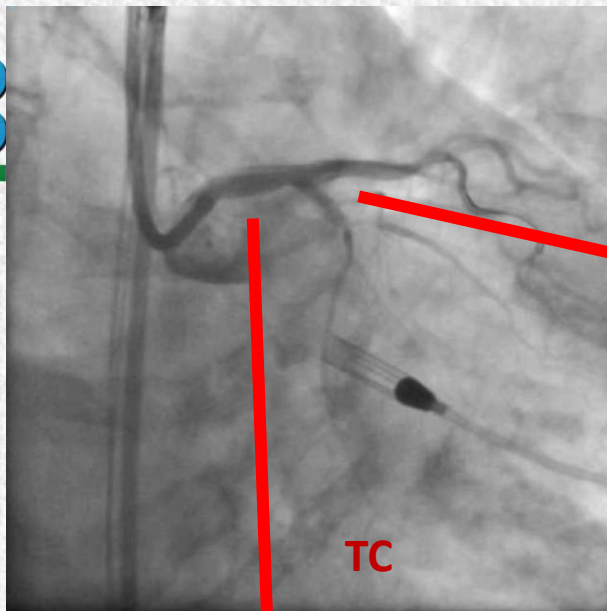


Final resul



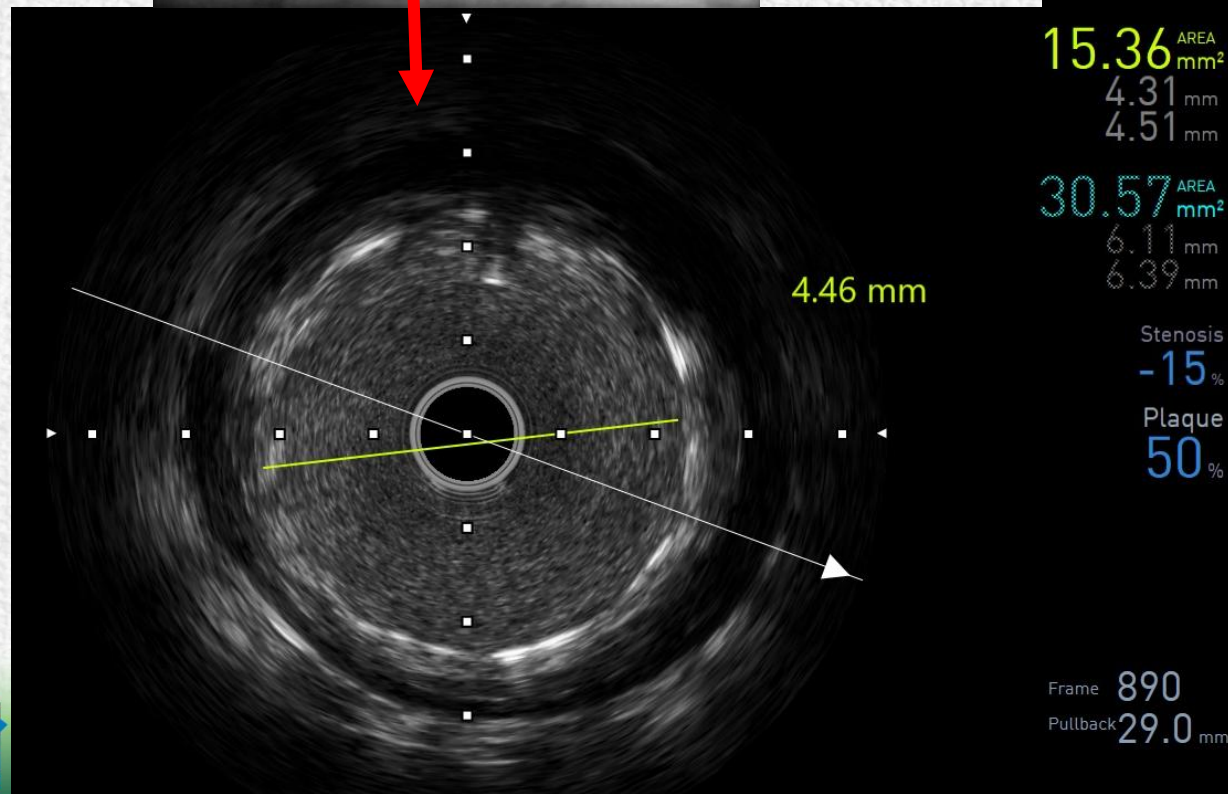
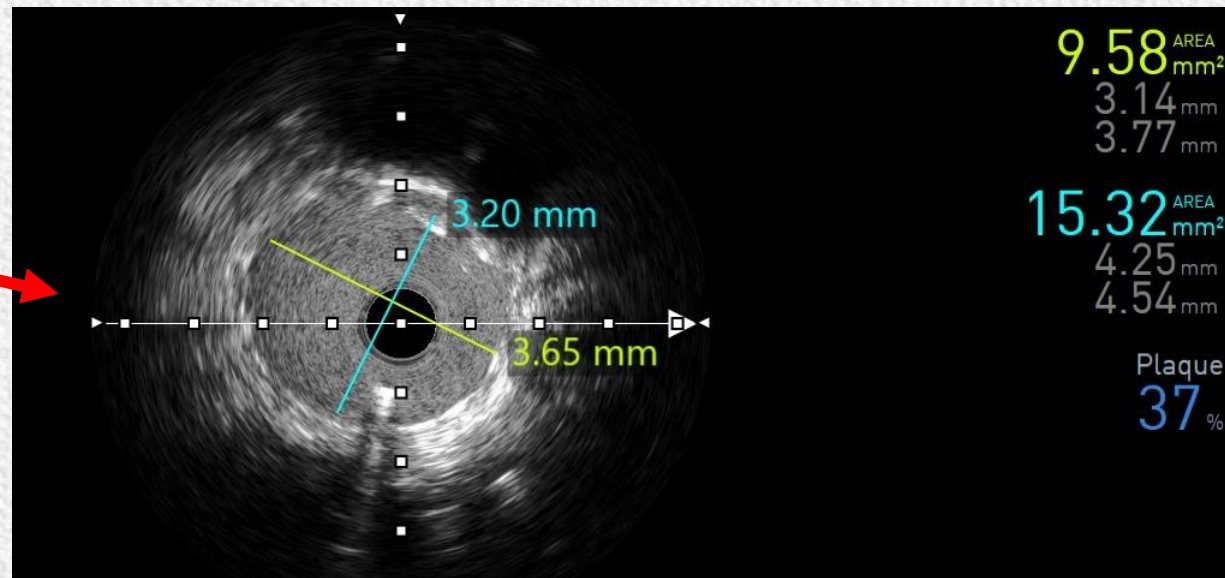
Proglide femoral closureal





LAD

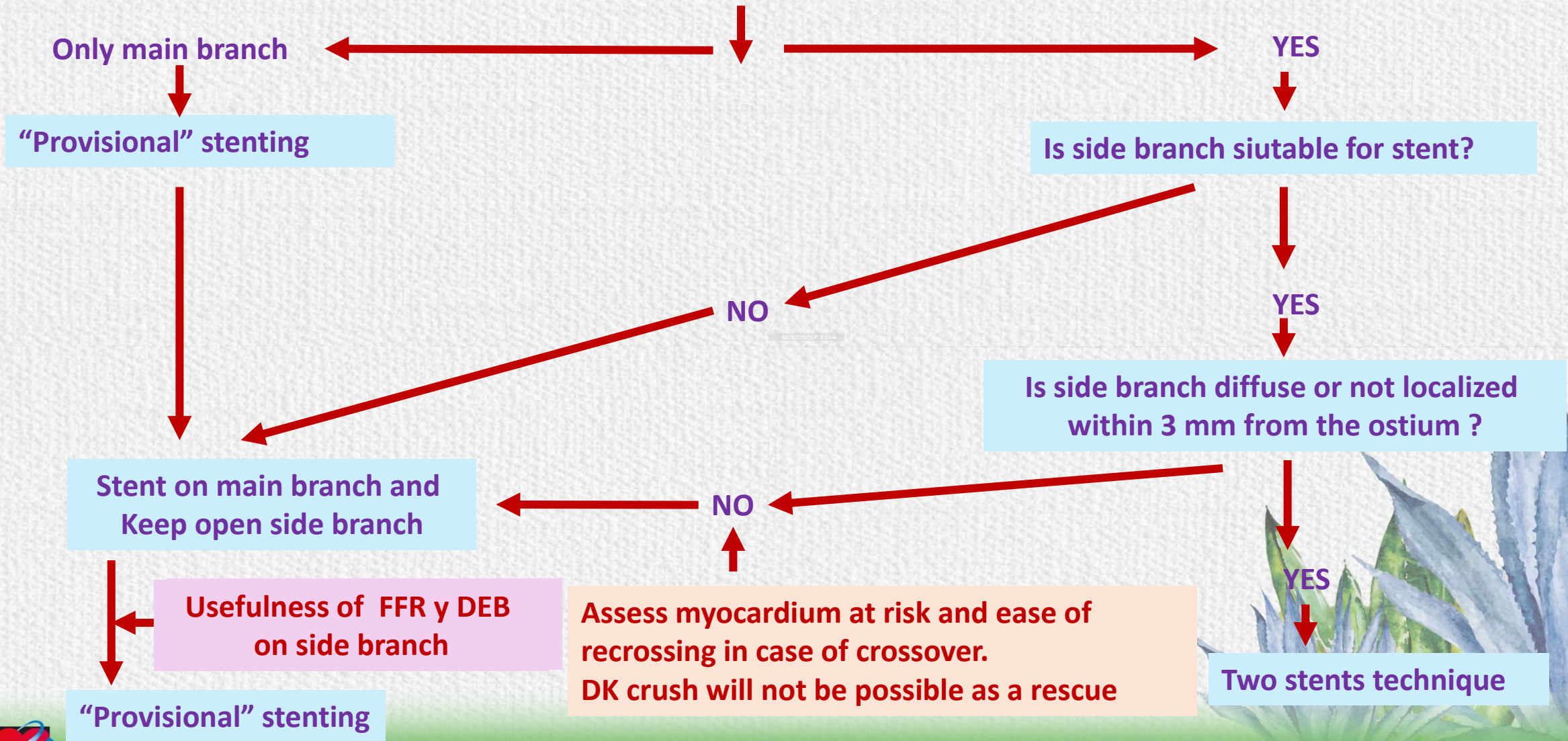
TC



IVUS. Final result after POT

TRUE BIFURCATION

significant stenosis on the main and side branch



FINAL MESSAGE

Once it has been decided that the patient is a candidate for PCI....

The choice of technique should be determined by the disease of the side branch, the myocardium at risk, the patient's clinical condition, and the team's experience.

Circulatory support may be useful in critically ill patients.

IVUS should be mandatory in the final evaluation after the POT.

If provisional stenting is chosen, FFR measurement and drug-eluting balloons in the side branch may improve outcomes. The provisional approach does not allow the conversion of two stents with the "DK crush" technique.

The DK crush technique has been shown to be superior to other techniques that involve the placement of two stents ("culotte")

In unstable patients, it is necessary to find the balance between performing an "academic" technique and the need to proceed simple and fast.

