# My Approach to Left Main Coronary Disease: Master's Skill Secret

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# Disclosure

- Dr D.-W. Park reports grants from Daiichi-Sankyo, ChongKunDang Pharm, and Daewoong Pharm; personal fees from Edwards and Medtronic; and grants and personal fees from Abbott Vascular

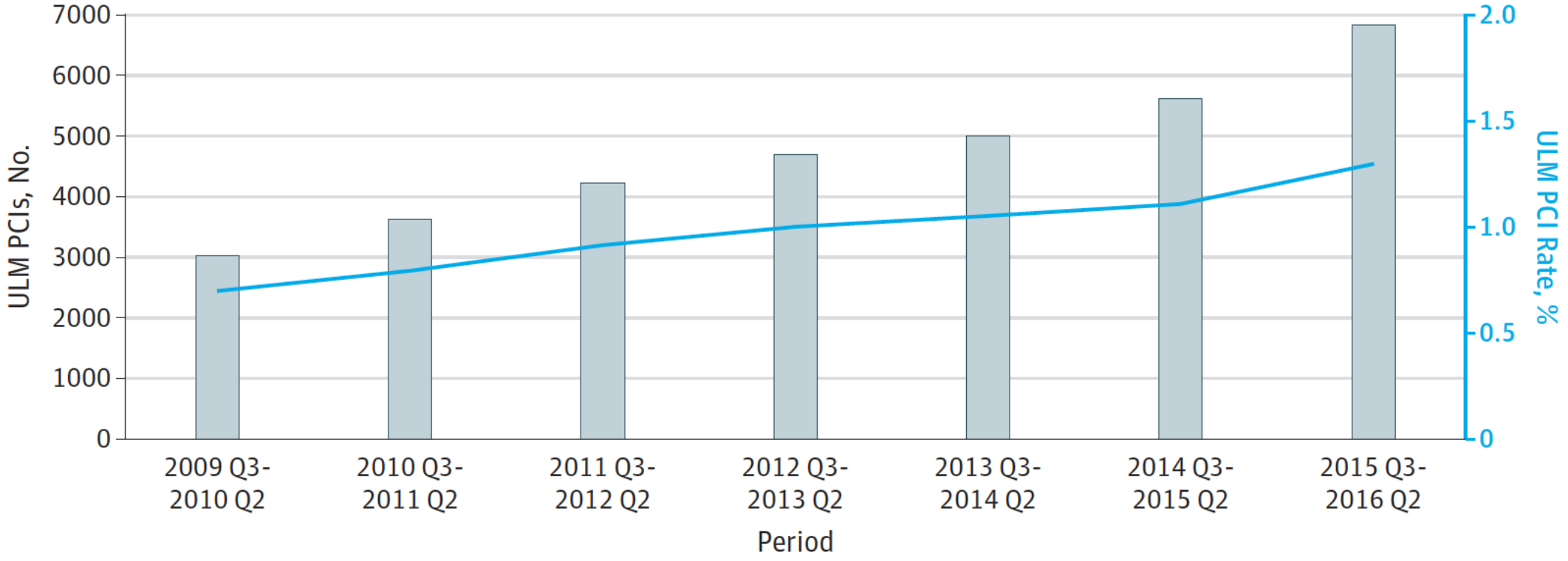
# Left Main PCI in the Contemporary PCI
# What Are Big Deal?

## Can Average Interventional Cardiologists Perform Average-Quality Left Main PCI?

# Contemporary Use and Trend of Left Main PCI: US NCDR Database

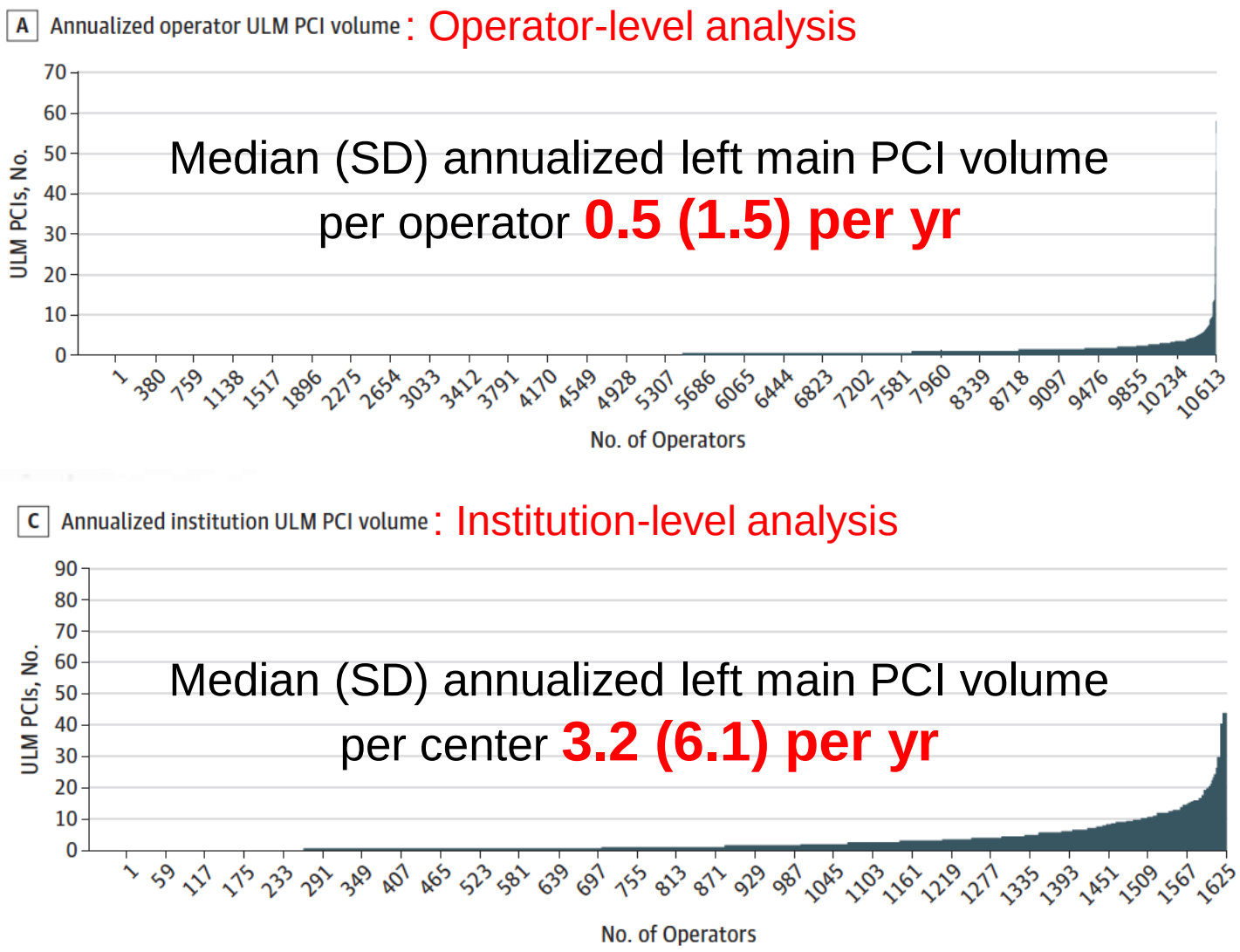
Unprotected left main PCI represented **1.0%** of all procedures, modestly increasing from **0.7%** to **1.3%** over time

Figure 1. Temporal Trends in Unprotected Left Main (ULM) Percutaneous Coronary Intervention (PCI)




Valle JA et al. JAMA Cardiol. 2019;4(2):100-109.

# Contemporary Use and Trend of Left Main PCI




"Only **16.5%** of operators and **53.7%** of facilities performing an average of ≥1 LM PCI annually"

Valle JA et al. JAMA Cardiol. 2019;4(2):100-109.

# Contemporary Use and Trend of Left Main PCI

## Left Main PCI Is Not Simple PCI

Table 3. In-Hospital Outcomes

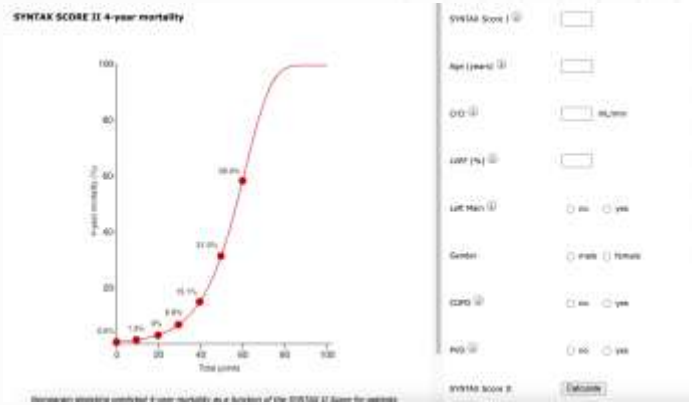
| Outcome | No. (%) | | | *P* Value |
|---|---|---|---|---|
| | Total (N = 3 342 162) | ULM PCI (n = 33 128) | All Other PCI (n = 3 309 034) | |
| Death, MI, stroke, or emergent CABG | 89 933 (2.7) | 2993 (9.0) | 86 940 (2.6) | <.001 |
| Death | 22 987 (0.7) | 1643 (5.0) | 21 344 (0.6) | <.001 |
| MI (biomarker positive) | 61 300 (1.8) | 1285 (3.9) | 60 015 (1.8) | <.001 |
| Stroke | 6480 (0.2) | 176 (0.5) | 6304 (0.2) | <.001 |
| Emergent CABG | 3443 (0.1) | 224 (0.7) | 3219 (0.1) | <.001 |

Valle JA et al. JAMA Cardiol. 2019;4(2):100-109.

# Left Main PCI in the Contemporary PCI

## What Are Big Deal?

## How Can We Do At Least Average Left Main PCI?




# HEART Team Approach : General Concept for 1st Decision-Making

- Possibility to achieve complete revascularization
- Surgical risk
- Resource availability and operator expertise
- Patient preferences

| Variable | Preoperative score | Combined score |
|---|---|---|
| Age (for each five years over 55 years) | 1 | 1 |
| BMI 30–40 kg/m² | 4 | 3 |
| BMI 40 kg/m² | 9 | 8 |
| Diabetes | 3 | 3 |
| Renal failure | 4 | 4 |
| Congestive heart failure | 3 | 3 |
| Peripheral vascular disease | 2 | 2 |
| Female gender | 2 | 2 |
| Chronic lung disease | 2 | 3 |
| Cardiogenic shock | 6 | n/a |
| Myocardial infarction | 2 | n/a |
| Concomitant surgery | 4 | n/a |
| Perfusion time 100–200 minutes | n/a | 3 |
| Perfusion time 200–300 minutes | n/a | 7 |
| Intra-aortic balloon pump | n/a | 5 |

STS, Society for Thoracic Surgeons; BMI, body mass index.

## Favors CABG

**Clinical characteristics**

-Low LVEF
-Concomitant cardiac surgery
-Doubtful DAPT adherence including high bleeding risk
-Diabetes with multivessel disease

**Anatomical aspects**

-Left main plus 3-vessel disease
-Combined complex anatomy not suitable for PCI

## Heart Team Approach

## Favors PCI

**Clinical characteristics**

-Urgent revascularization
-Serious comorbidity, high surgical risk, and frailty
-Reduced life expectancy

**Anatomical aspects**

-Ostial or shaft LMCA disease
-Left main plus 1-vessel disease

# Technical Concept on LMCA PCI

- Consider LV support
  - No strict guide- ongoing studies will help (etc. IABP, Impella, PVAD et al)
- Access
  - 7 or 8F for femoral access
  - 7F radial guide have changed the landscape.
- Imaging is the fundamental tool of LMCA PCI
- Physiology can help to diagnose significant LMCA disease as well
- Volume drives outcomes – experience is everything
- Comfort with evaluation and treatment of distal LMCA bifurcations is mandatory

# When do We use MCS for left main PCI?

## (When the benefit outweighs the risk)

- What is current status of MCS selection and impact on outcomes?
- Which patient and lesion criteria can guide assessment of benefit versus risk?
- Should we have consensus/standardized approach?

## MCS for Left Main PCI
## Potential Standardized Criteria

### Selection Matrix

| Cardiac Reserve | Lesion Complexity | RCA Status | MCS Risk |
|---|---|---|---|
| Normal | Low | No disease/revascularized | Low |
| Intermediate | Intermediate | Diseased but patent | Intermediate |
| Low | High | CTO with left collaterals | High |

DRIVING THE FUTURE of PRECISION MEDICINE

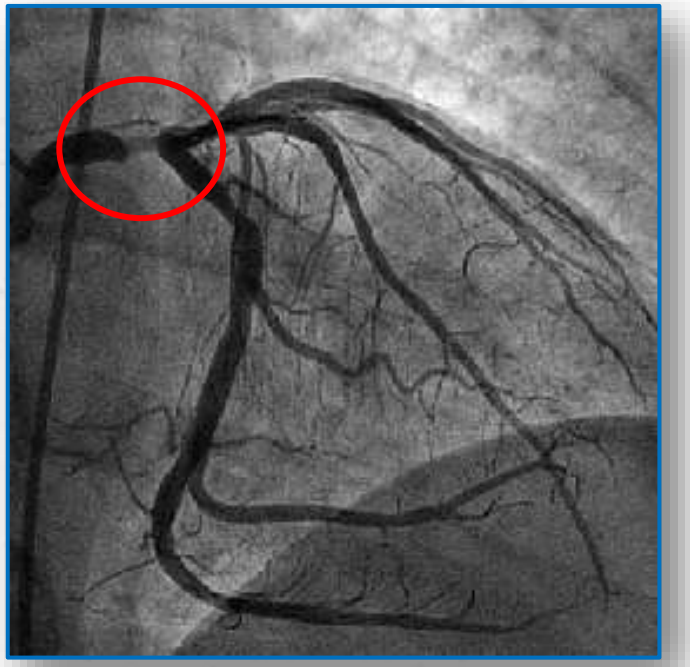
# For LMCA PCI

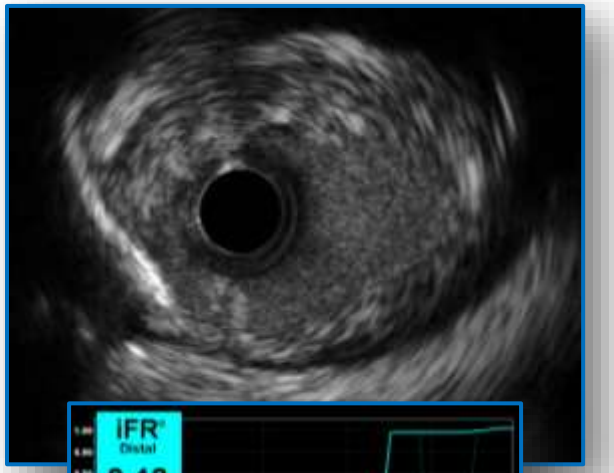
## DIAGNOSIS

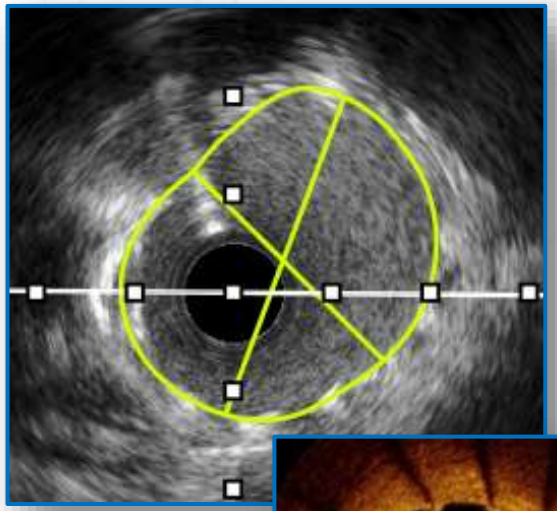
Assessment

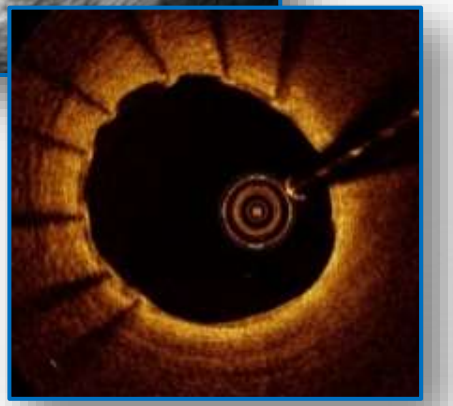
## INTERVENTION

Guidance Optimization



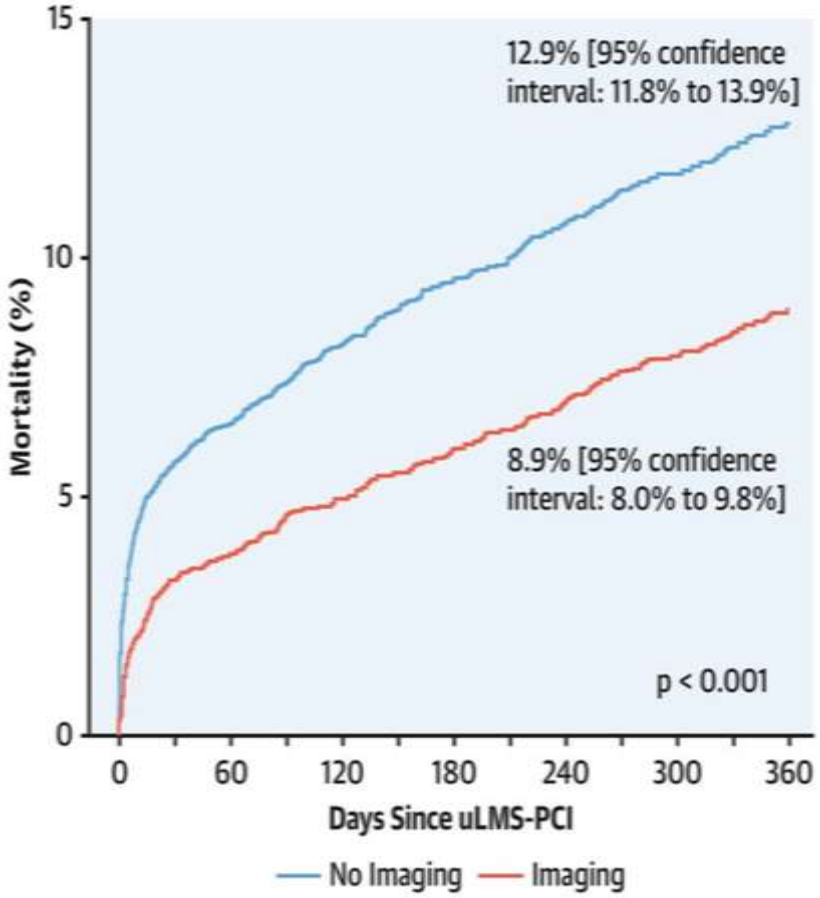




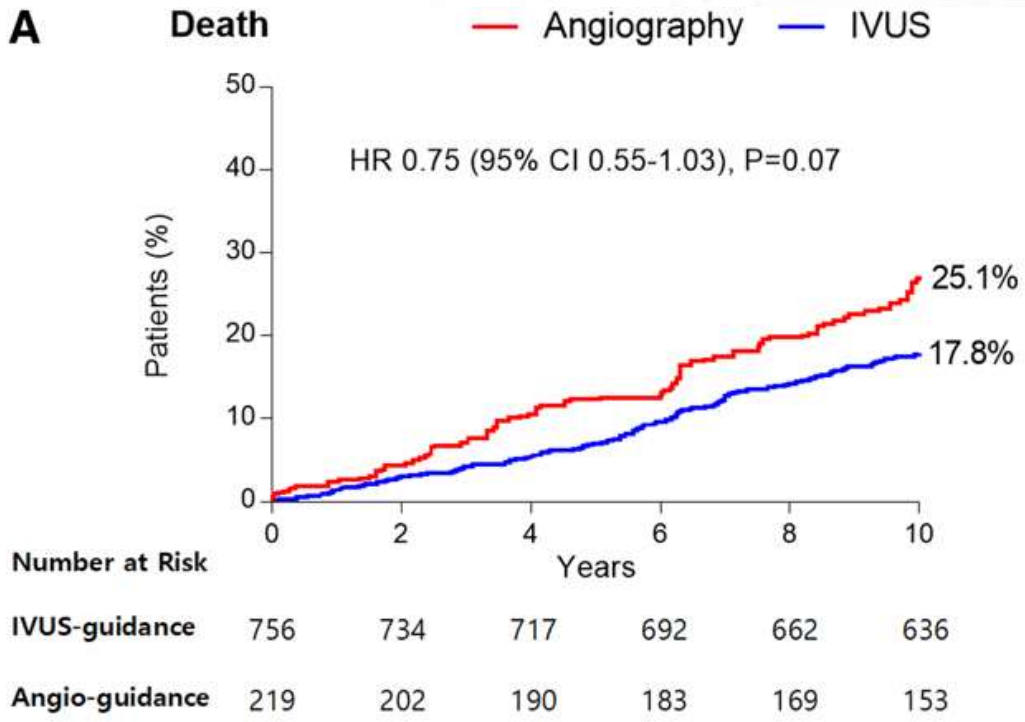
# IVUS Can Improves Survival in Left Main PCI : Most Data From Observational Studies

Propensity Matched BCIS Analysis 2007-2014




Kinnaird, T et al. J Am Coll Cardiol Intv. 2020;13(3):346-57

MAIN-COMPARE 10-Year IPTW-Adjusted




DY Kang, et al. Circ Cardiovasc Interv 2021;14(10):e011011

# OPtimizaTIon of Left MAin PCI with IntravascuLar Ultrasound. The OPTIMAL Randomized Controlled Trial

OPTIMAL

Adrian Banning  Luca Testa  Jose M de la Torre Hernandez

Enrolling
Over 550 pts included so far
(target N = 800)

# Practical Imaging and Physiology Use for Left Main PCI

Assessment of Intermediate (50-70%) LM Stenosis Severity
(vs FFR)

↓

Assessment for Proper Vessel Preparation

↓

Evaluation of Vessel Size and Lesion Length
(Including Bifurcation Vessel Sizing for Proper Bifurcation Sizing)

↓

Post-PCI Stent Optimization
Decision on side-branch (LCX) Tx

## Factors that favor choices between treatment pathways for left main coronary stenosis in patients with stable ischemic heart disease

### Favors OMT

- Minimal symptoms
- Good quality of life
- Tolerates medical therapy and reaches target goals
- Adheres to careful follow-up
- Patient preference

### Favors PCI

- High surgical risk
- Low complexity plaques
- Low quality CABG conduits
- Elderly patients with serious comorbidities
- Preference for fast recovery

### Favors CABG

- Diabetes
- Complex MVD
- Moderate/severe LV dysfunction
- Requires concomitant cardiac surgery
- Long term survival

European Heart Journal (2022) **43**, 4635–4643

EDITORIAL

# Imaging and Physiology Get Along in the Left Main Coronary Artey Disease

## The Case for Intravascular Ultrasound and Instantaneous Wave-Free Ratio

Jose M. de la Torre Hernandez, MD, PhD

Circ Cardiovasc Interv. 2021;14(6):e010887

## Left Main Coronary Artery intermediate stenosis

**IVUS**

< 4.5 mm² | 4.5 – 6 mm² | > 6 mm²

- < 4.5 mm² → Revascularization
- 4.5 – 6 mm² → FFR <0.8 → Revascularization; FFR ≥0.8 → iFR ≤0.89 → Revascularization; iFR >0.89 → Deferral
- > 6 mm² → Deferral

**FFR** <0.8 | ≥0.8 — **iFR** ≤0.89 | >0.89

Discordant FFR / iFR values in LAD / LCx: **IVUS** in LMCA-LAD + LMCA-LCx

- → Revascularization
- → Deferral

**Pro-IVUS**
- Mid-shaft LMCA lesion
- Distal LMCA lesion
- Lesions in LAD / LCx
- PCI-eligible if significant LMCA lesion

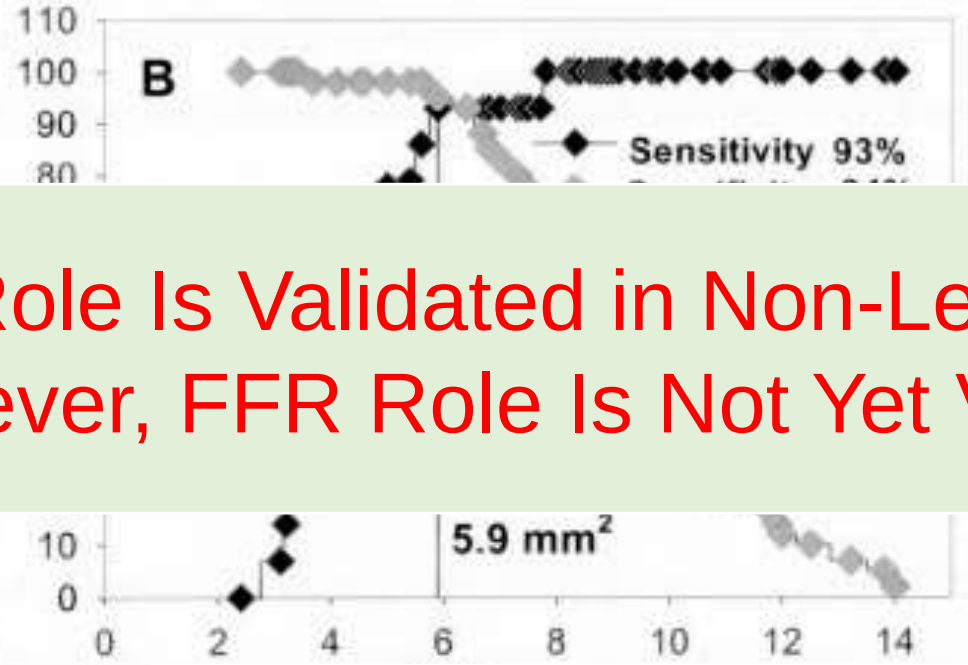
**Always put IVUS/FFR/iFR data in context:**
- Symptoms
- Electrocardiographic / echocardiographic findings
- LMCA lesion complexity
- Extension of coronary artery disease
- PCI / CABG eligible patient
- Patient profile (age, frailty, bleeding risk, comorbidities,…)

**Pro-FFR / (iFR)**
- Ostial LMCA lesion
- Ostial LAD / LCx involvement
- Akinesia (scar) LAD / LCx

**(pro-iFR)**
- Lesions in LAD / LCx
- Severe LV hypertrophy

# IVUS or FFR Assessment of LMCA Stenosis Severity
# : FFR-Matched IVUS Criteria

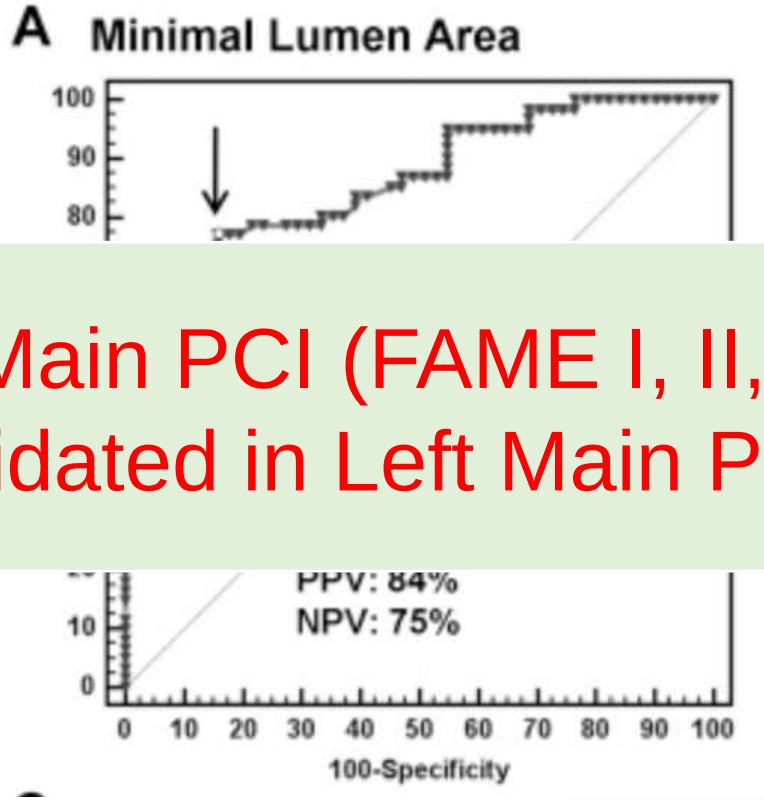
Western Cohort




MLA 5.9

Jasti, et al. Circulation. 2004;110:2831–2836

Asian Cohort



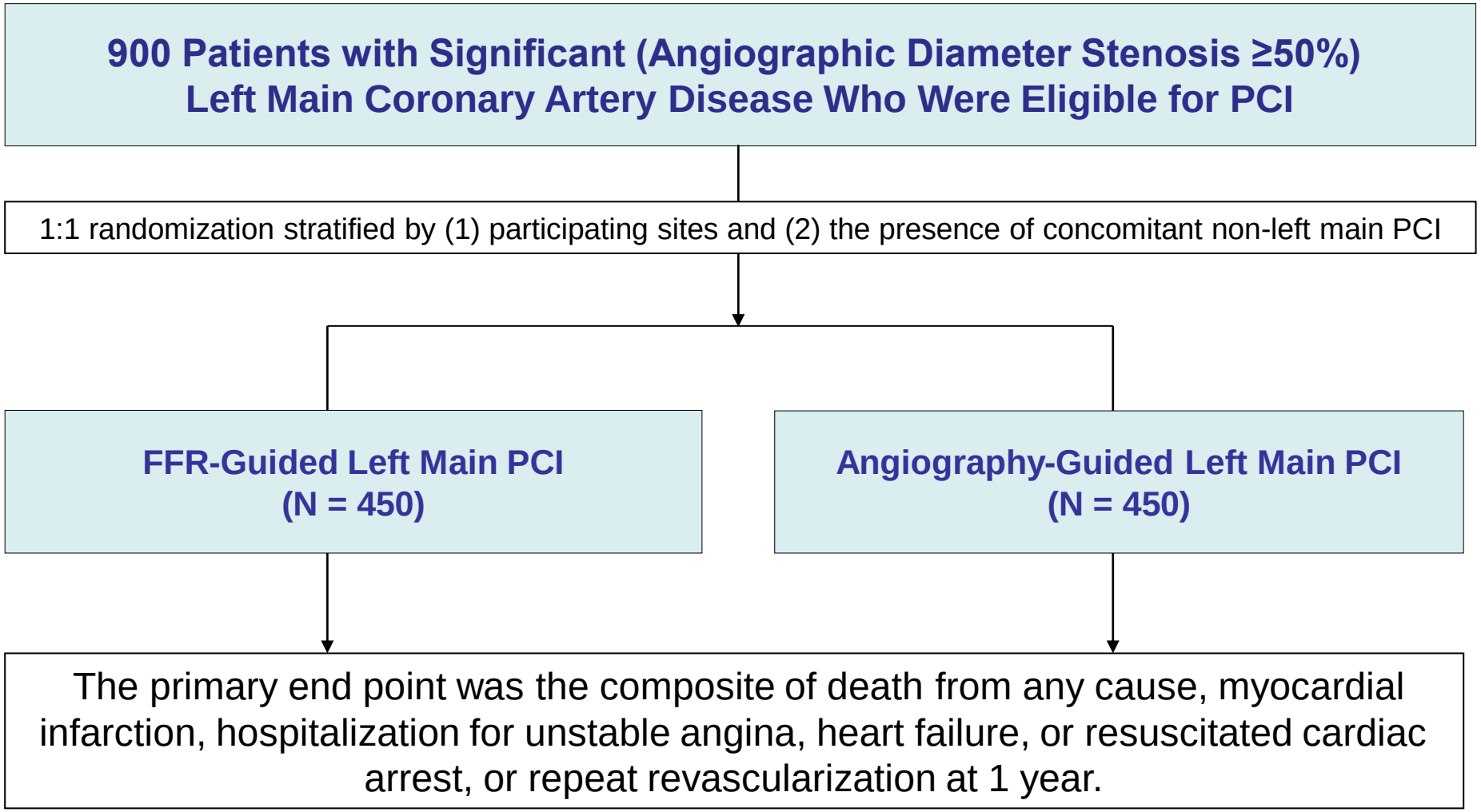

MLA 4.5

Park, et al. JACC: CI. 2014, 7(8), 868-874

FFR Role Is Validated in Non-Left Main PCI (FAME I, II, III)
However, FFR Role Is Not Yet Validated in Left Main PCI

Fractional Flow Reserve versus Angiography for Treatment-Decision and Evaluation of Significant Left MAIN Coronary Artery Disease

# FATE-MAIN Trial



# Practical Imaging or Physiology Use for Left Main PCI

Assessment of Intermediate Left Main Stenosis Severity

↓

Assessment for Proper Vessel Preparation

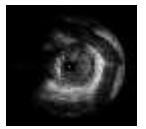
↓

Evaluation of Vessel Size
(Including Bifurcation Vessel Sizing for Proper Bifurcation Sizing)

↓

Post-PCI Stent Optimization
Decision on side-branch (LCX) Tx

Angiographic Evidence of Calcified Lesion



Intravascular Imaging: IVUS/OCT

***Calcium thickness ≥ 0.5 mm, length ≥ 5 mm, arc ≥ 180°, protruding nodule**

Imaging Catheter/Device Unable to Cross Lesion

Atherectomy/Uncrossable Algorithm

Intravascular Imaging to assess Residual Calcium Burden and Need for IVL

Imaging Criteria Not Met

1:1 Sized NC/Specialty Balloon Inflated to Nominal Pressure

Full Expansion?

Yes

Proceed with PCI

No

Calcium Meets Requirements for Modification*

IVL

Proceed with PCI

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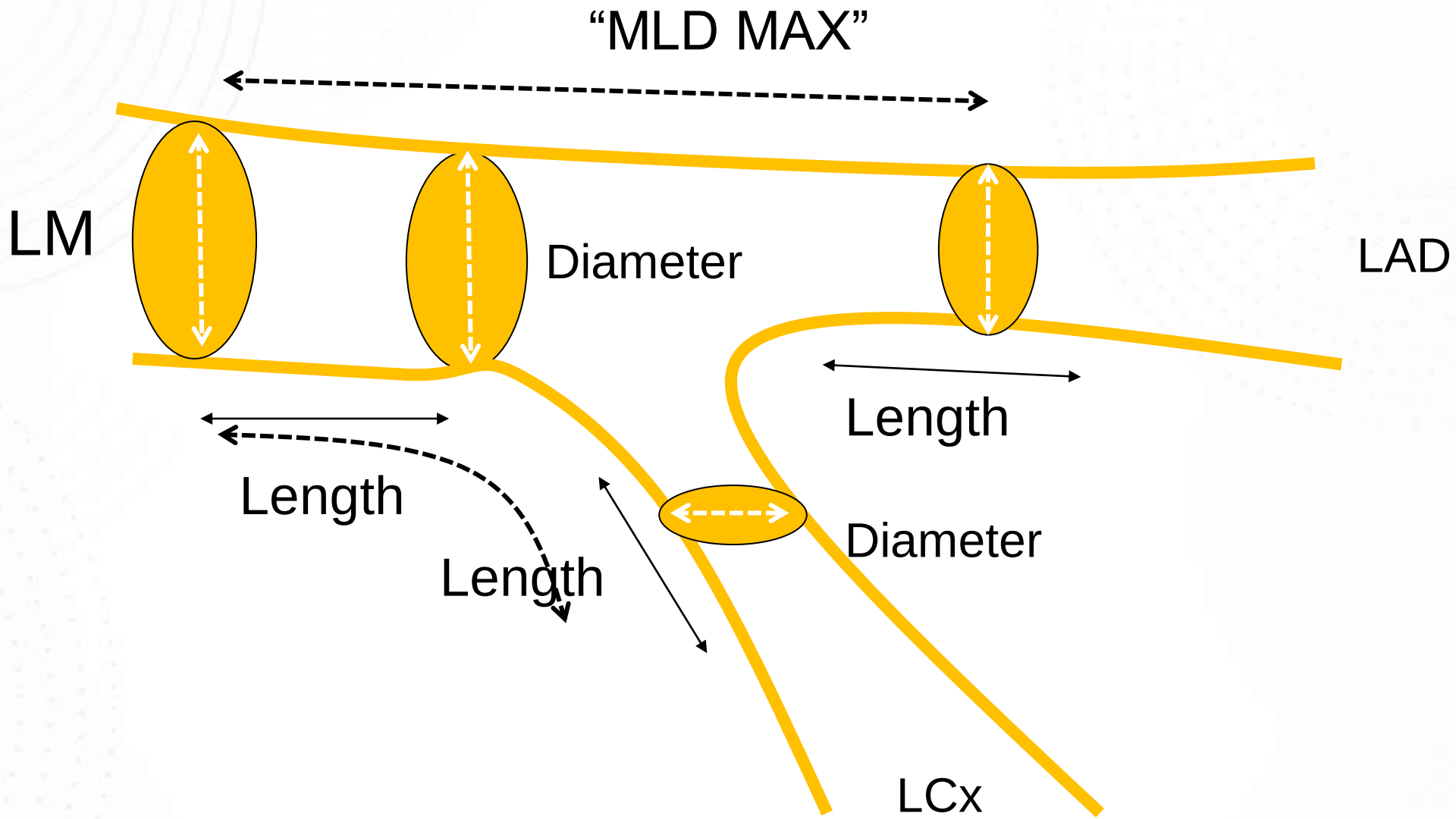
# Intravascular Imaging Measurements



## Preference for provisional stenting

-Small LCx
-No LCx disease (< 50%) (1,0,0) (1,1,0)
-Lesion in ostial LCx extending < 5 mm
-Wide angle LAD / LCx
-No significant ostial LCx disease by IVUS
(MLA > 4 $mm^2$, no calcified nodule, no layered plaque)

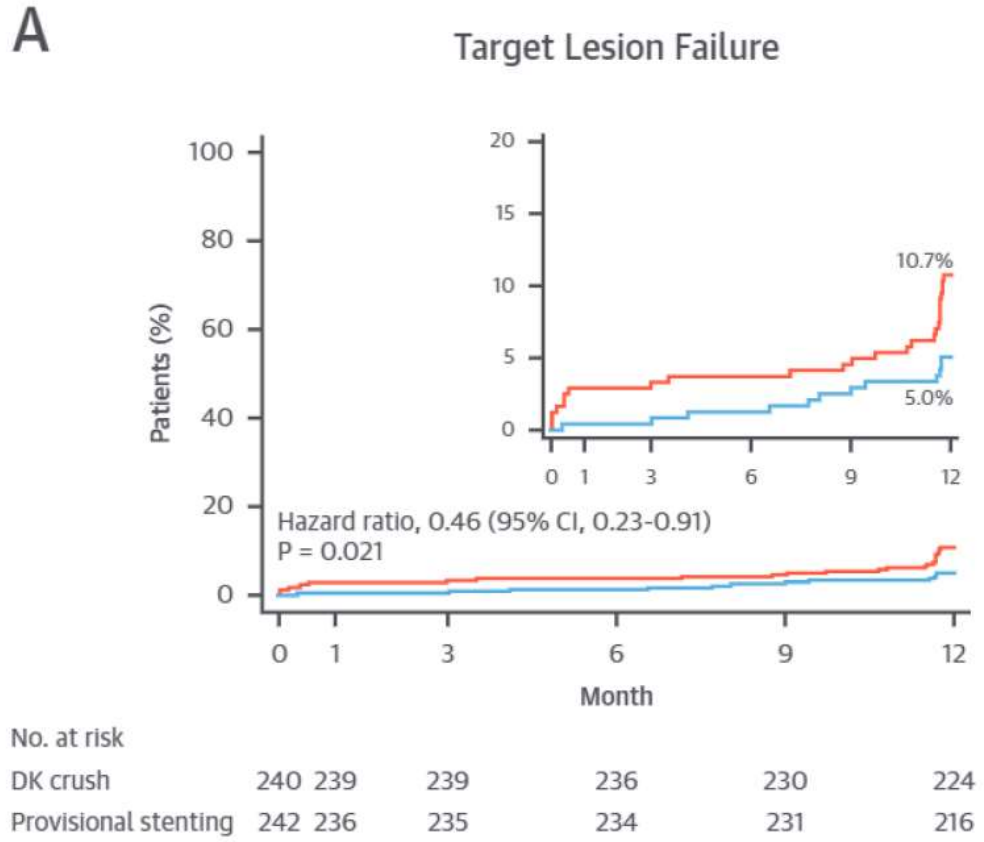
## Preference for 2-stents technique

Large LCx with any of the following:
-Significant and long (> 5 mm) lesion in ostial LCx (1,1,1) (0,1,1) (1,0,1)
-Complex lesion in ostial LCx
-Narrow angle LAD / LCx
-Significant ostial LCx disease by IVUS
(MLA < 4 mm2 , calcified nodule, layered plaque)

# Strategy For True LM Bifurcation Disease ?

## Two Stent Is Good

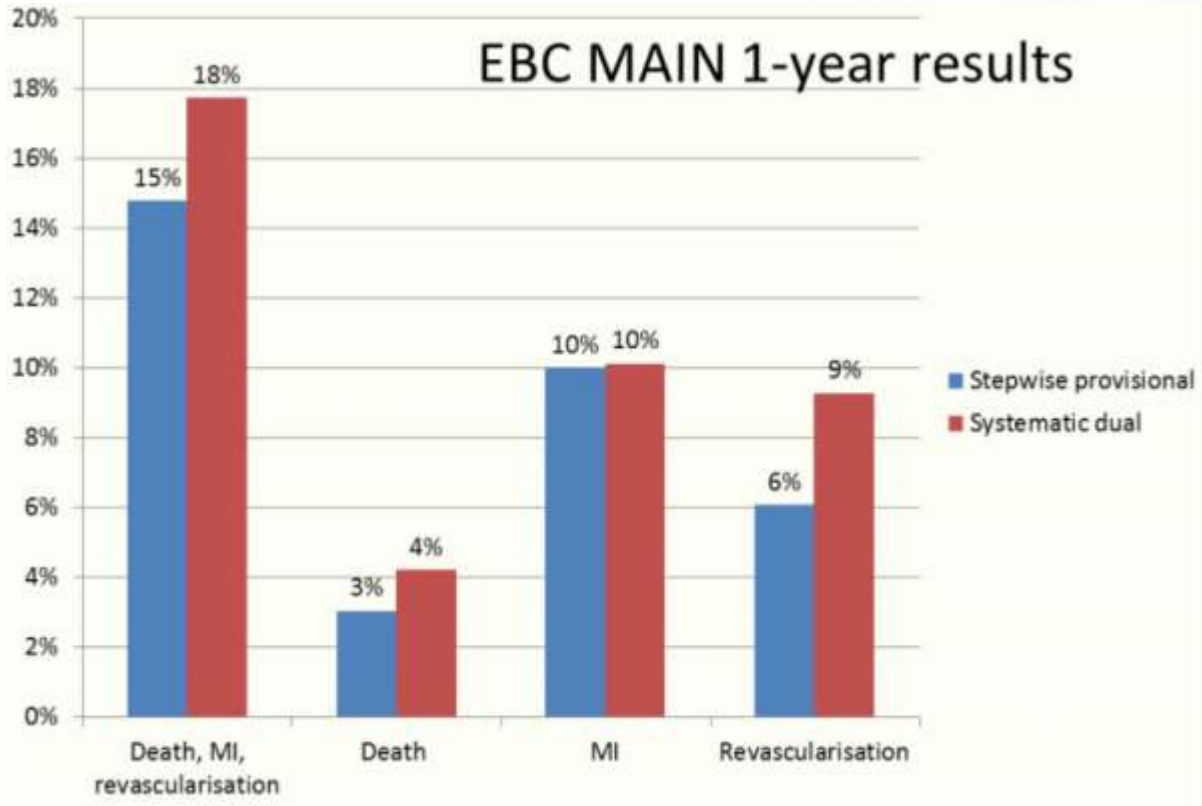
DKCRUSH-V




J Am Coll Cardiol 2017;70:2605-17

## One Stent Is Good

EBC-MAIN




European Heart Journal (2021) 42, 3829–3839

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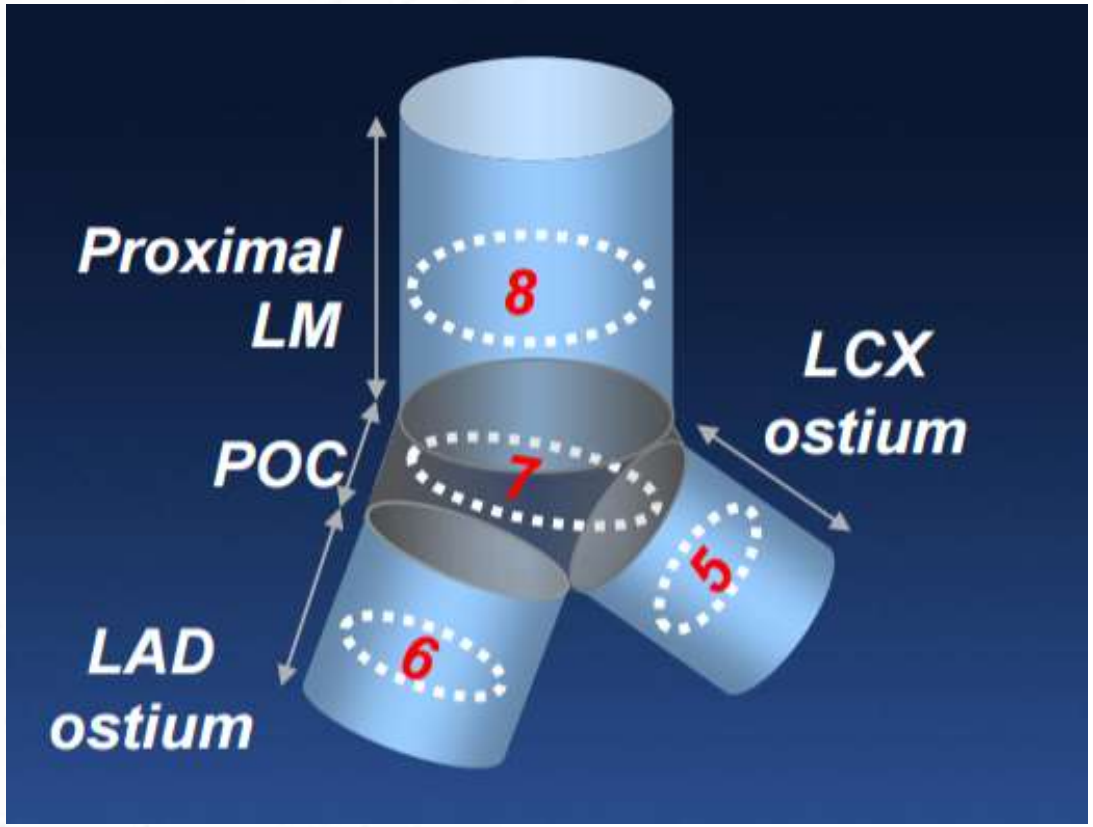
↓

Post-PCI Stent Optimization

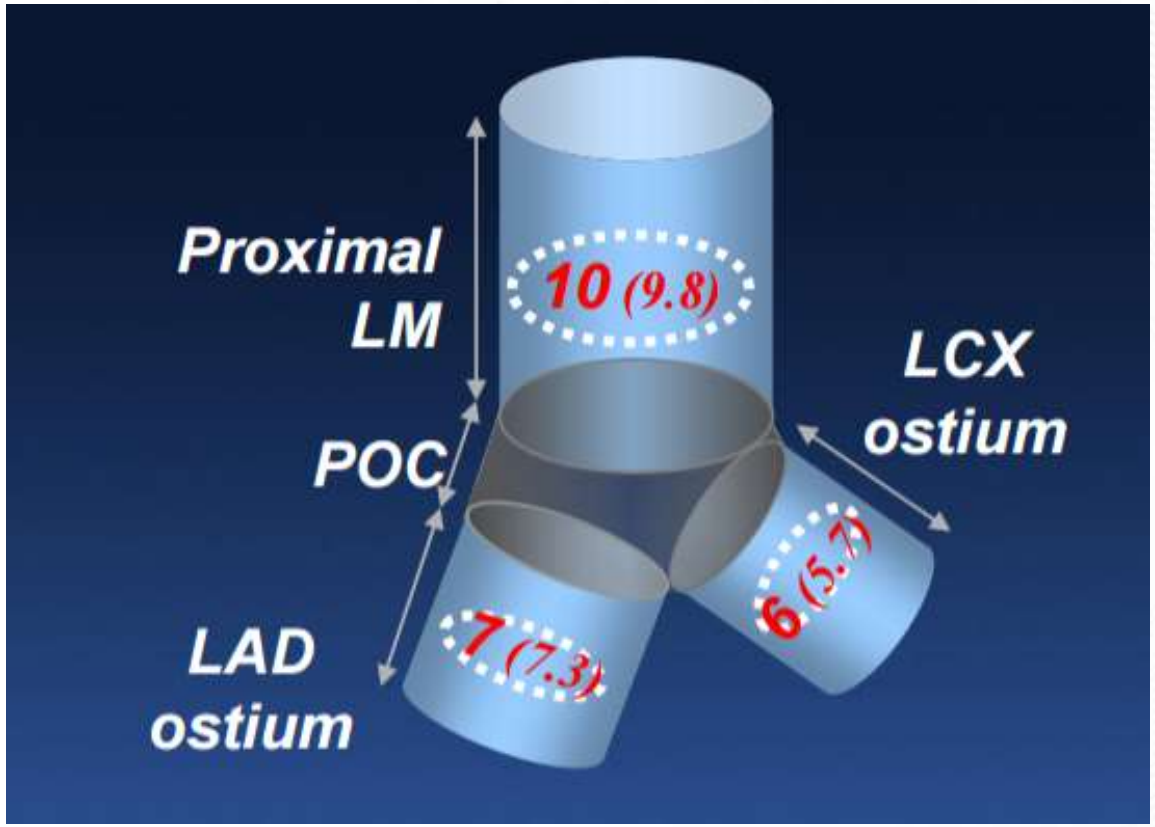
# LM IVUS MSA Criteria

Asan Medical Center Criteria




Kang SJ, et al. Circ Cardiovasc Interv 2011;4:562-9

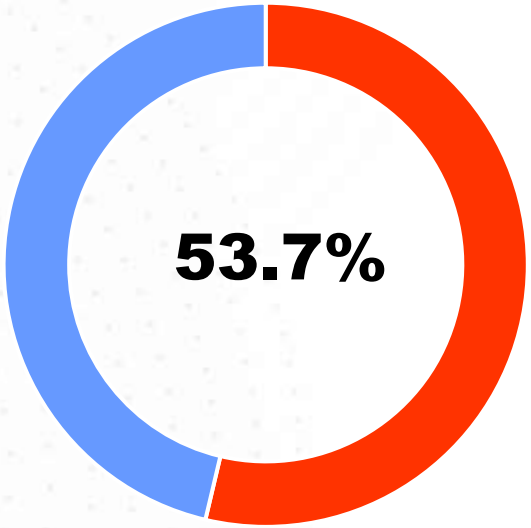
EXCEL Criteria




EXCEL Trial Analysis
A. Maehara TCT 2018

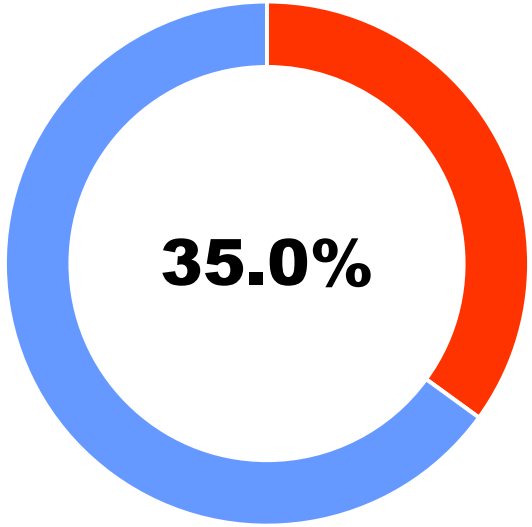
# Two Stent Technique in Randomized Trials

PRECOMBAT Trial



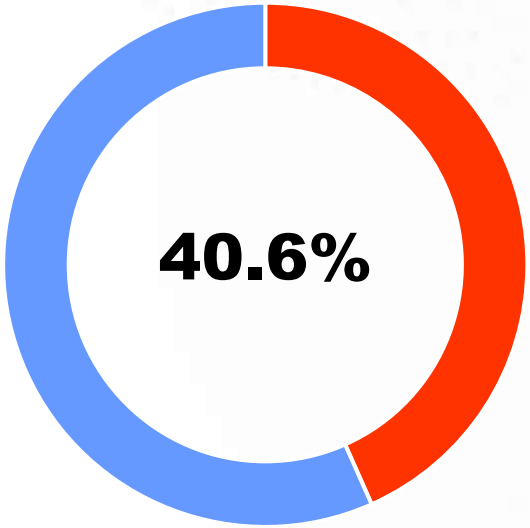

Crush Technique

EXCEL Trial




T Stenting

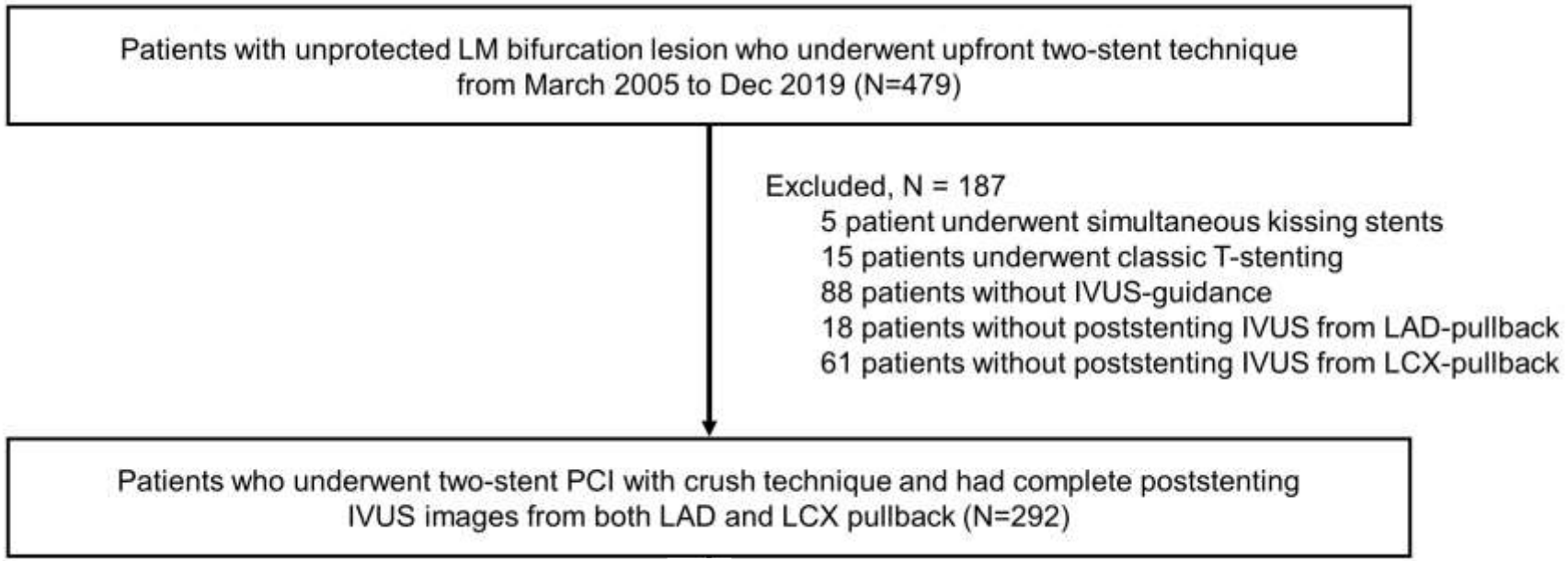
NOBLE Trial




Culotte

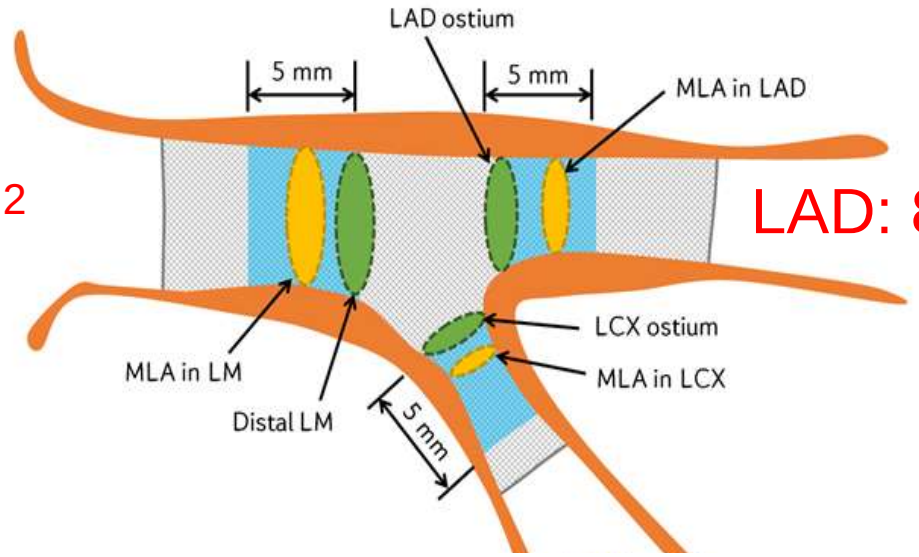
# New Data for LM IVUS Criteria for Crush Technique Based on Long-Term (5-Year) Clinical Outcomes

292 Patients
- Treated By Crush Technique
- Complete IVUS Imaging



# ROC Curve Analysis: LM Crush Technique

LM: 11.8 mm²

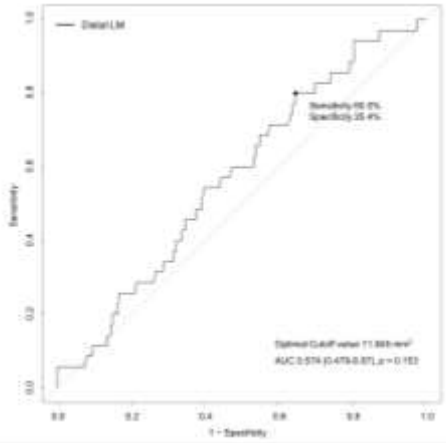



LAD: 8.3 mm²

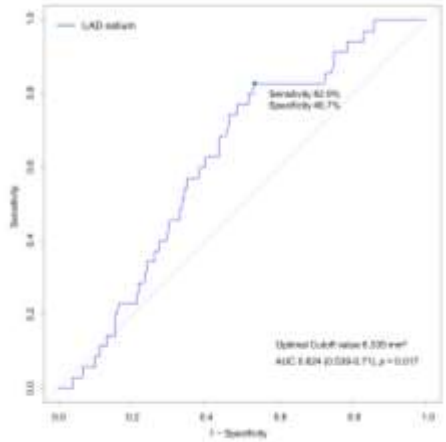
LCX: 5.7 mm²

| | Cutoff point | AUC (95% CI) | Sensitivity | Specificity | *P* value |
|---|---|---|---|---|---|
| **IVUS-measured MSA (mm²)** | | | | | |
| Distal LM | 11.8 | 0.57 (0.48–0.67) | 80.0% | 35.4% | 0.153 |
| LAD ostium | 8.3 | 0.62 (0.54–0.71) | 82.9% | 46.7% | 0.017 |
| LCX ostium, by LCX pullback | 5.7 | 0.64 (0.55–0.74) | 71.4% | 54.9% | 0.006 |

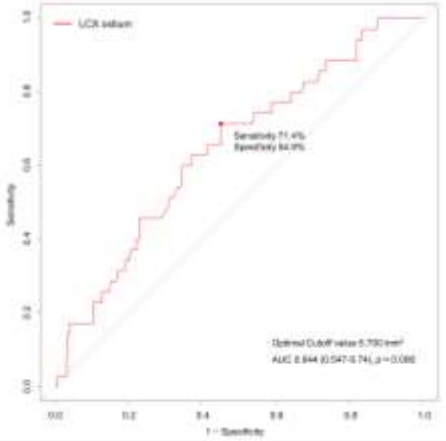
LM



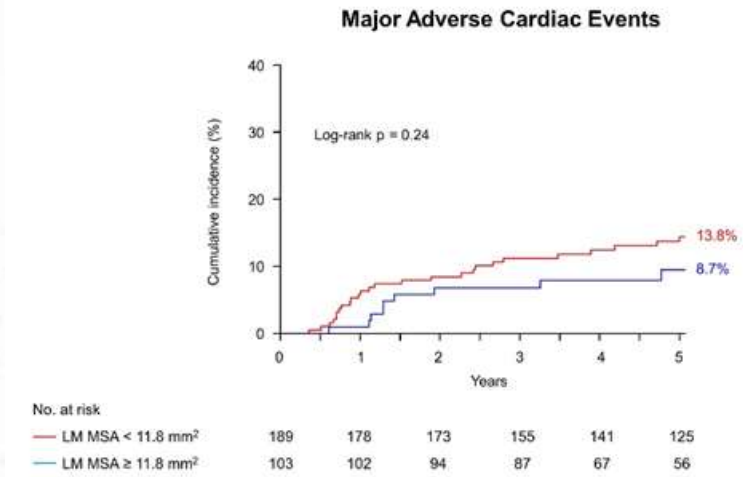
LAD

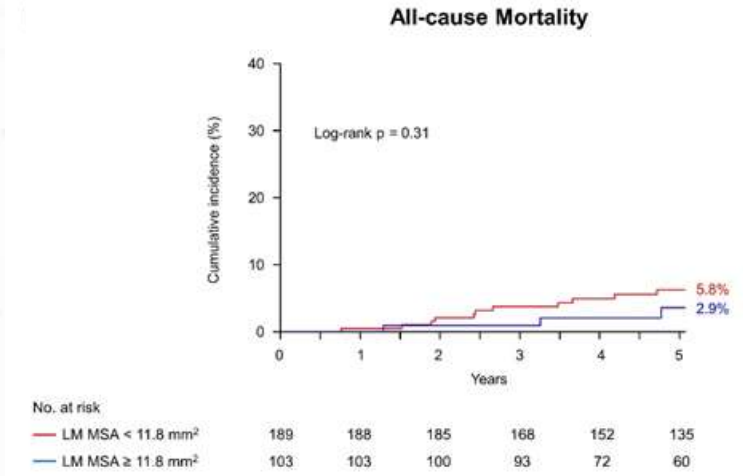


LCX

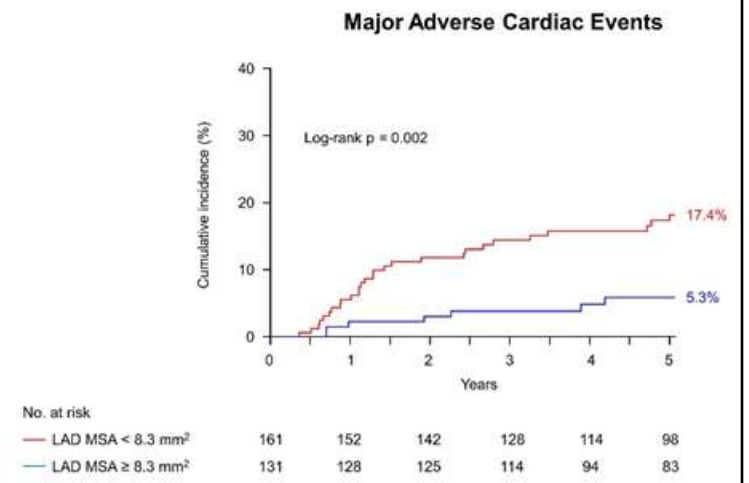


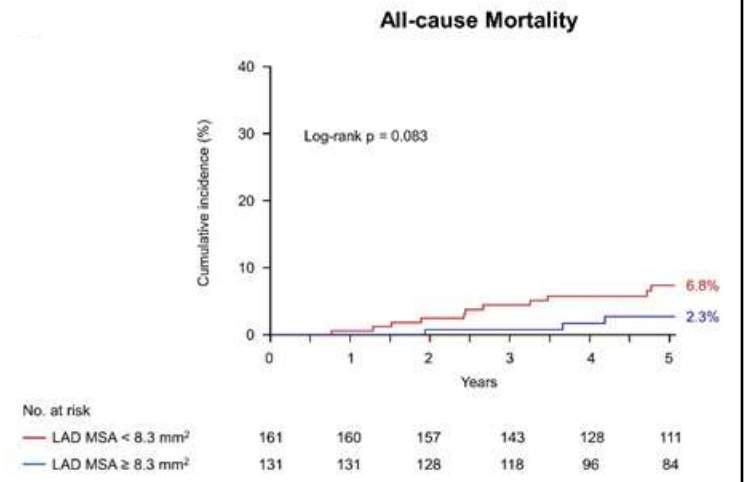
## LM<11.8 mm$^2$: 64.7%



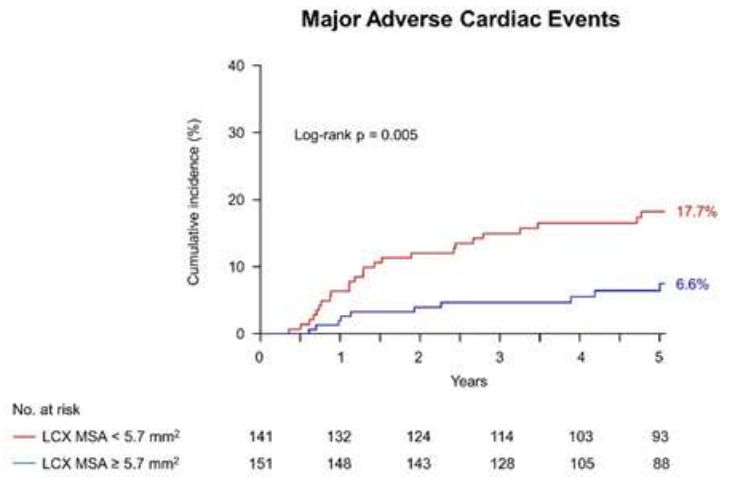



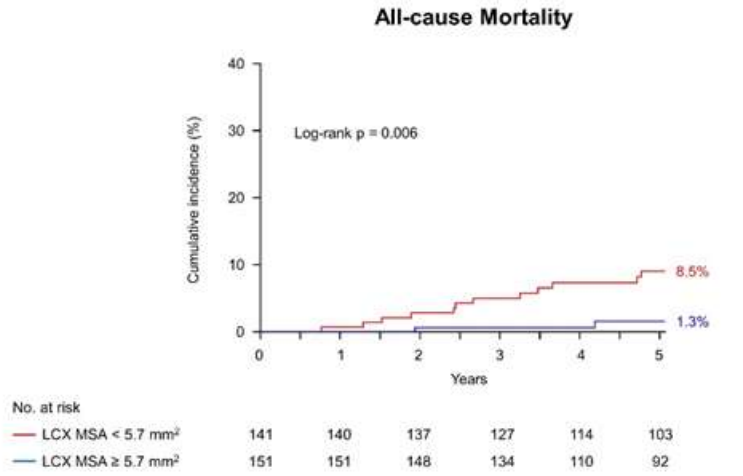

## LAD<8.3 mm$^2$: 55.1%




## LCX<5.7 mm$^2$: 48.3%



# Practical Imaging or Physiology Use for Left Main PCI

Assessment of Intermediate Left Main Stenosis Severity

↓

Assessment for Proper Vessel Preparation

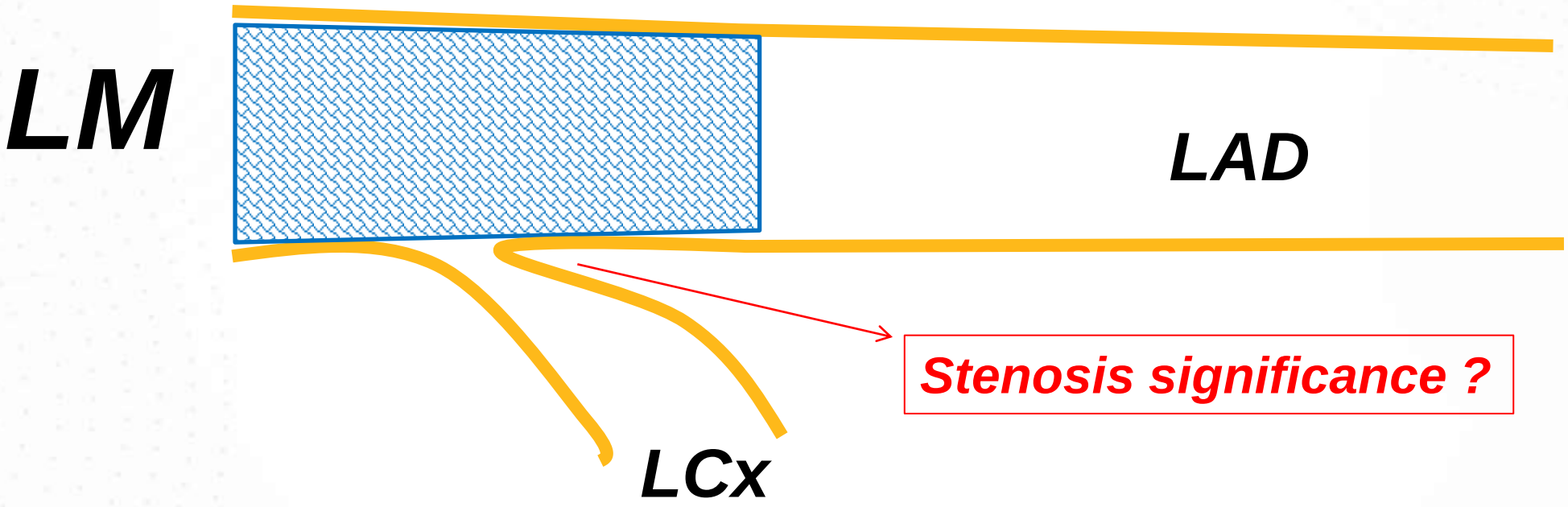
↓

Evaluation of Vessel Size
(Including Bifurcation Vessel Sizing for Proper Bifurcation Sizing)

↓

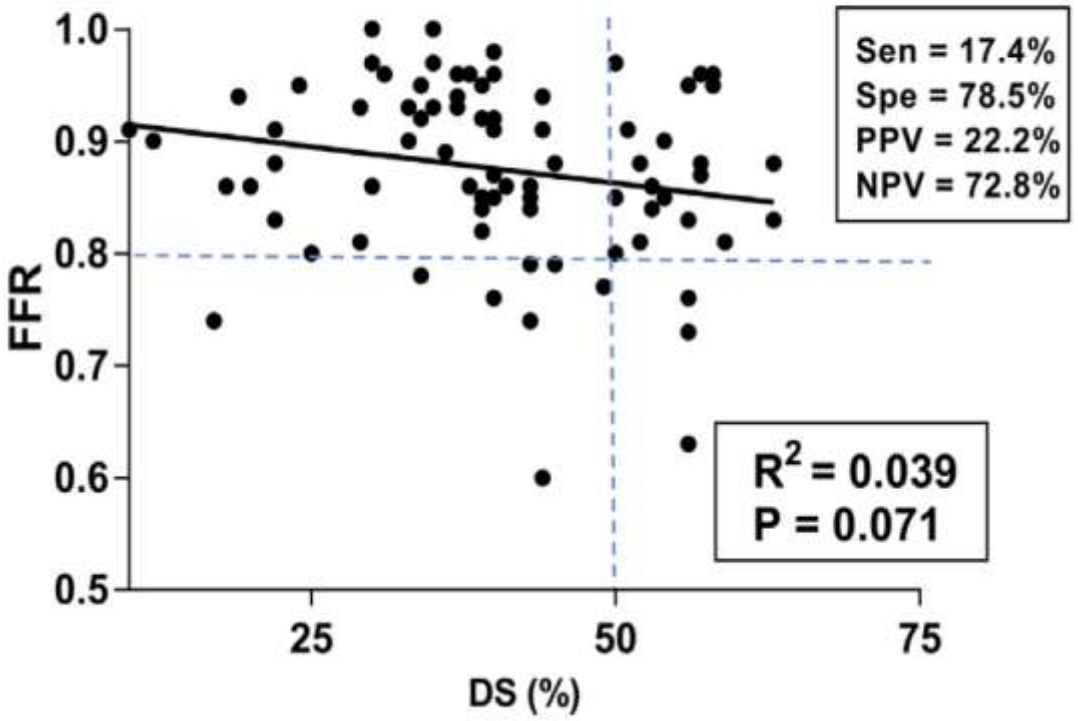
Decision on side-branch (LCX) Tx

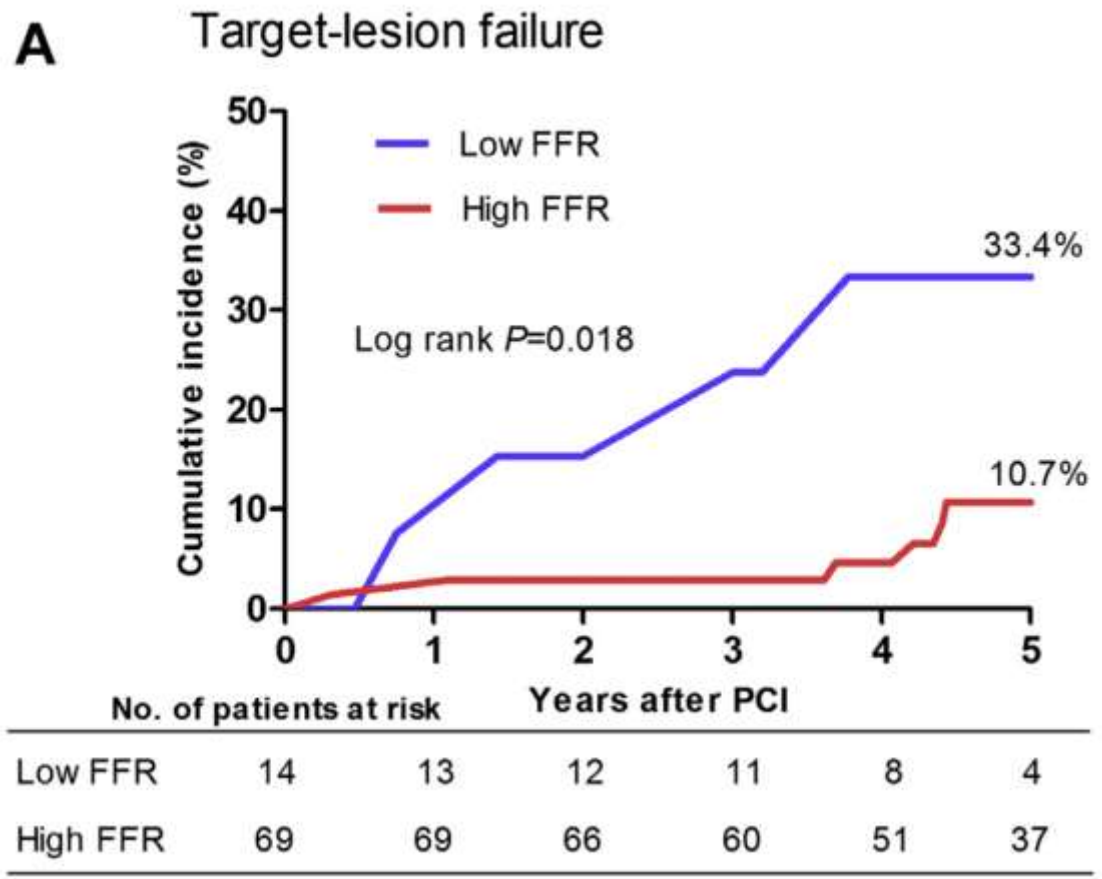
# Use of the pressure guide to evaluate the compromise of LCx after stent implantation from LM to LAD in the provisional stenting approach



# LCX Jailing and FFR Role in Left Main Cross-Over Stenting

**FIGURE 1** Correlation Between FFR and % DS of Jailed LCx After LM Simple Crossover Stenting




Lee CH et al. JACC Intv 2019;12:847-855

JACC: CARDIOVASCULAR INTERVENTIONS

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EDITORIAL COMMENT

# Left Circumflex Coronary Artery After Left Main Crossover Stenting

## Jailed Yet Mostly Innocent*

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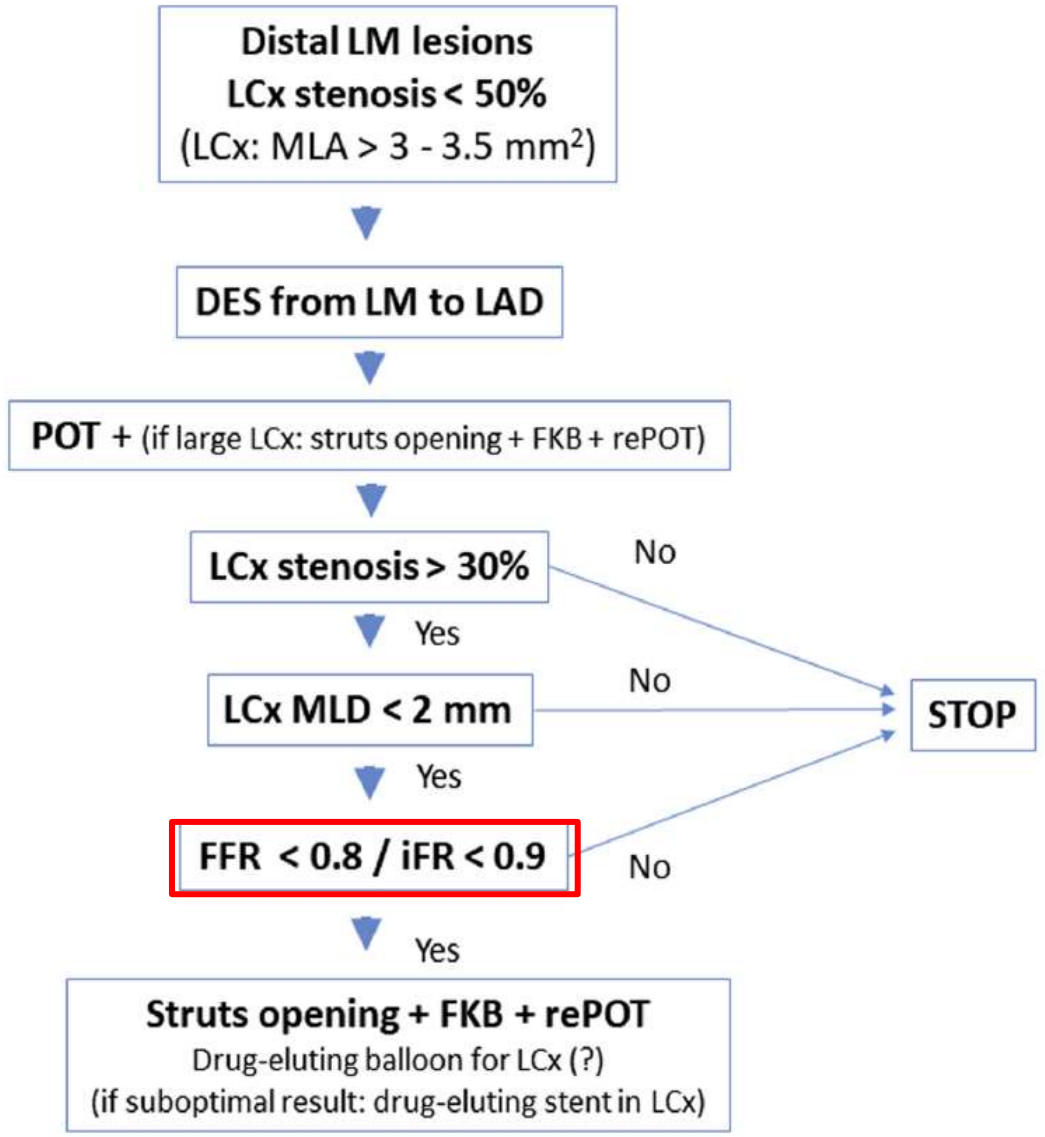
**FIGURE 1** A Proposed Algorithm for LM Provisional Stenting Strategy




de la Torre Hernández. JACC Intv 2019; 12: 856-8

# Key SUMMARY: Left Main PCI with Imaging and Physiologic Concept

## Assessment and PCI guidance in LMCA disease

| | | |
|---|---|---|
| **Severity assessment** | **IMG** | **FFR / iFR** |
| **Involvement of ostial LAD/ostial LCx or MV/SB**<br>**(STRATEGY: provisional vs 2-stents)** | **IMG** | **FFR / iFR** |
| **Calcification**<br>**(plaque preparation technique / optimization)** | **IMG** | |
| **Sizing**<br>**Balloon pre/POT and Stent** | **IMG** | |
| **Optimization**<br>**Expansion / Apposition / Edge dissection / Deformation** | **IMG** | |
| **SB compromise after provisional stenting** | | **FFR / iFR** |

**IMPROVING OUTCOMES**

# Summary: My Approach to Left Main PCI

- LMCA PCI is less common than non-LMCA PCI
  - Volume matters b/c of increased risk for MACCE
- HEART team approach typical for decision-making on LMCA disease
- Intravascular imaging is foundational for LMCA PCI and should be considered standard of care
- Proper way to perform distal LMCA bifurcations is to be debated
- Clinical role of FFR for LMCA PCI will be confirmed in FATE-MAIN Trial.