ASSESSMENT OF LM CAD BY IVUS

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I RATIONALE: WHY IVUS OVER ANGIOGRAPHY

- **Limitations of 2D Coronary Angiography in the Left Main (LM):** Invasive angiography is frequently inaccurate for grading Left Main stenosis due to the absence of a normal reference segment, vessel foreshortening, overlapping daughter branches (LAD and LCx), and ostial contrast streaming.
- **Superiority of Intravascular Ultrasound (IVUS — Class IIa for intermediate LM stenosis; Class I to guide LM PCI, ESC 2024):**
  - **Deep Tissue Penetration:** IVUS provides **5 to 8 mm** of radial tissue penetration, enabling complete visualization of the large-caliber Left Main vessel wall and the **External Elastic Membrane (EEM)**.
  - **No Blood Clearance Required (Ostial LM Advantage):** Unlike Optical Coherence Tomography (OCT), which requires complete contrast flushing to clear red blood cells, IVUS images through blood—making IVUS the modality of choice for **Aorto-Ostial Left Main lesions** where contrast continuously washes back into the aortic sinus.

II PRE-INTERVENTION: SIZING AND SIGNIFICANCE (THE EXAM CUTOFFS)

- **IVUS Minimum Lumen Area (MLA) Thresholds for Left Main Intervention:**
  - **MLA greater than 6.0 mm2:** Safe to **defer** revascularization (PCI or CABG); clinical event rates with medical therapy alone are very low.
  - **MLA less than 4.5 mm2:** Severe stenosis; **revascularization is strongly indicated**.
  - **MLA between 4.5 and 6.0 mm2 (“The Gray Zone”):** Requires physiological assessment with **Fractional Flow Reserve (FFR) or instantaneous wave-free ratio (iFR)** (or non-invasive stress testing) to confirm functional ischemia before committing to revascularization.
  - **Plaque Burden:** A cross-sectional **plaque burden greater than 70 percent** at the MLA site further supports the decision to intervene.

III DISTAL LM BIFURCATION ASSESSMENT

- **Provisional Single-Stent vs. Upfront Two-Stent Strategy Selection:** Because most LM lesions involve the distal bifurcation, IVUS interrogation of both the **LAD and LCx ostia** is essential prior to stenting:
- **Criteria Favoring an Upfront Two-Stent Strategy (e.g., DK-Crush or Culotte):** If the **LCx ostium** exhibits heavy calcification, a **plaque burden greater than 50 percent**, or an **MLA less than 3.7 mm2**, the LCx is at high risk of acute occlusion after crossover LM-to-LAD stenting, favoring an upfront two-stent technique.
- **Stent Landing Zone Selection:** IVUS identifies healthy proximal LM and distal LAD/LCx reference segments with **less than 50 percent plaque burden** (and absence of lipid-rich/calcified rings) to minimize geographic miss and stent edge dissection.

IV POST-INTERVENTION: STENT OPTIMIZATION (THE KANG CRITERIA)

- **Preventing Stent Thrombosis and In-Stent Restenosis (ISR):** Stent under-expansion is the strongest modifiable predictor of Left Main stent failure. The **Kang Criteria ("The 5-6-7-8 Rule")** define the minimum acceptable post-PCI Minimum Stent Area (MSA) targets in each segment of the Left Main bifurcation:
- **LCx Ostium:** MSA must be **greater than 5.0 mm2**.
- **LAD Ostium:** MSA must be **greater than 6.0 mm2**.
- **Polygon of Confluence (Bifurcation Core):** MSA must be **greater than 7.0 mm2**.
- **Distal / Shaft Left Main Trunk:** MSA must be **greater than 8.0 mm2**.
- **Mandatory Optimization Action:** If any segment fails to meet these area targets on post-deployment IVUS, further high-pressure post-dilatation using appropriately sized **Non-Compliant (NC) balloons** is required.

Assessment Phase & Anatomical Segment	IVUS Parameter	Actionable Threshold / Target	Clinical Decision / Action
Pre-PCI: Left Main Trunk	Minimum Lumen Area (MLA)	**MLA > 6.0 mm2**	**Defer** revascularization safely
Pre-PCI: Left Main Trunk	Minimum Lumen Area (MLA)	**MLA 4.5 to 6.0 mm2** (Gray Zone)	Perform **FFR or iFR** to confirm ischemia
Pre-PCI: Left Main Trunk	Minimum Lumen Area (MLA)	**MLA < 4.5 mm2** (Asian data: **4.5–4.8 mm2**)	**Proceed with Revascularization** (PCI or CABG)
Pre-PCI: LCx Ostium	Ostial MLA & Plaque Burden	**LCx MLA < 3.7 mm2** or **Plaque Burden > 50%**	High risk of side-branch loss -> favors **Upfront Two-Stent Strategy**
Post-PCI: Kang "5-6-7-8" Rule	Minimum Stent Area (MSA)	**LCx > 5 mm2; LAD > 6 mm2; POC > 7 mm2; LM Shaft > 8 mm2**	Perform high-pressure **NC balloon post-dilatation** if below target

V THE INDIAN CLINICAL CONTEXT

- **Smaller Body Surface Area and Reference Vessel Size:** Indian patients generally have a smaller body surface area and smaller native coronary dimensions than Western cohorts.
- **Adjusted Asian MLA Threshold:** Applying the Western 6.0 mm2 cut-off (LITRO) can lead to over-stenting in smaller Asian arteries; Korean FFR-correlation studies suggest about **4.5 to 4.8 mm2**, and in the gray zone FFR should decide.
- **Diabetic Calcification Assessment:** Due to the high prevalence of long-standing **Diabetes Mellitus** in India, IVUS is critical for identifying deep, thick circumferential calcium rings (**thickness greater than 0.5 mm and arc greater than 270 degrees**) that require **Intravascular Lithotripsy (IVL)** or **Rotational Atherectomy** prior to stent deployment.

KEY REFERENCES

- **Kang SJ, Mintz GS, Park DW, et al.:** Mechanisms of in-stent restenosis after drug-eluting stent implantation: intravascular ultrasound analysis in unprotected left main coronary artery disease, *Circulation: Cardiovascular Interventions*.
- **de la Torre Hernandez JM, et al. (LITRO):** Prospective application of pre-defined intravascular ultrasound criteria for assessment of intermediate left main coronary artery lesions, *Journal of the American College of Cardiology*, 2011.