Left Main Intervention

Michael S. Lee, MD, FACC, FSCAI

Assistant Professor

UCLA School of Medicine

Catheterization and Cardiovascular Interventions 00:000–000 (2011)

Interventional Rounds

Percutaneous Coronary Intervention of Unprotected Left Main Coronary Artery Disease: Procedural Strategies and Technical Considerations

Michael S. Lee,[1] MD, FACC, Gregg W. Stone,[2] MD, FACC, Seung-Jung Park,[3] MD, FACC, Paul Teirstein,[4] MD, FACC, Jeffrey Moses,[2] MD, FACC, Antonio Colombo,[5] MD, FACC, and David E. Kandzari,[6]* MD, FACC

Data have emerged demonstrating the safety and efficacy of percutaneous coronary intervention (PCI) of the unprotected left main (ULM) artery. The 2009 American College of Cardiology/ American Heart Association/Society for Cardiovascular Angiography and Interventions focused guidelines for PCI no longer state that ULM PCI is contraindicated in patients with anatomic conditions that are associated with a low risk of procedural complications and clinical conditions that predict an increased risk of adverse surgical outcomes. ULM PCI should be performed by operators with experience in the management of the anatomic complexities of left main and multivessel disease, specifically in issues relating to bifurcation disease, calcification, and hemodynamic support. Patients with ostial or shaft disease have lower risk of restenosis compared with distal bifurcation disease. Drug-eluting stents (DES) should be used whenever possible as they reduce clinical restenosis. Intravascular ultrasound is an integral component of the procedure as it provides accurate assessment of lesion severity and can confirm optimal stent expansion and apposition. Compliance with dual antiplatelet therapy for at least 12 months is essential if DES are used. A collaborative, multidisciplinary approach with a "Heart Team" represented by a cardiac surgeon, interventional cardiologist, and non-invasive cardiologist may optimize patient education and objective decision making when obtaining informed consent. Application of clinical and angiographic variables into risk models facilitates appropriate patient selection. Randomized clinical trials will address unanswered issues and help build consensus between cardiology and surgical societies to inform clinical decision making and optimize the outcomes for patients with ULM coronary artery disease.

Key words: left main coronary disease; percutaneous coronary intervention; diagnostic cardiac catheterization

Patient Selection

- **Clinical factors**
  - Younger age
  - Normal renal function
  - Preserved LV function
  - Elective presentation
- **Anatomic factors**
- **Poor surgical candidates**
  - Advanced age
  - Poor distal targets
  - Porcelain aorta
  - Co-morbidities

Informed Consent

- Treatment options and risks/benefits
- *Ad hoc* PCI should be discouraged
- "Heart Team"

Antiplatelet Therapy

- Contraindication
- Compliance
- Premature discontinuation

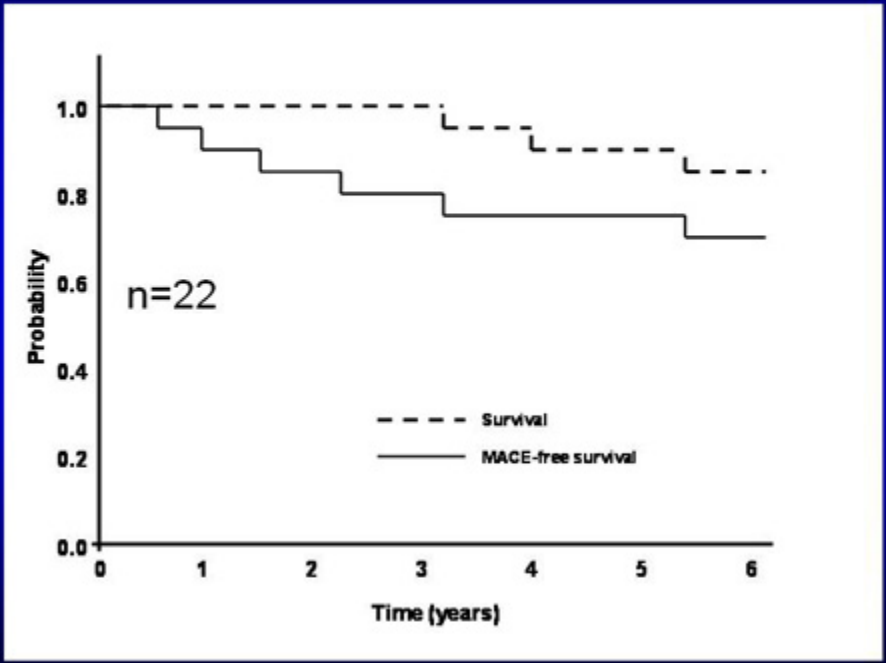
The American Journal of Cardiology

Long-Term Outcomes After Percutaneous Coronary Intervention of Left Main Coronary Artery for Treatment of Cardiac Allograft Vasculopathy After Orthotopic Heart Transplantation

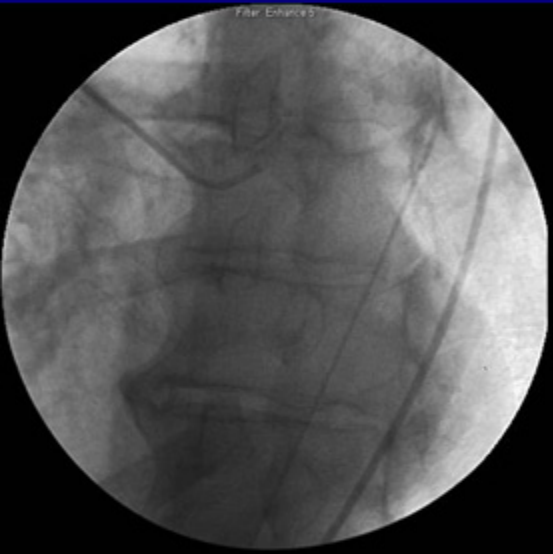
Michael S. Lee, MD*, Tae Yang, MD, William Fearon, MD, Michael Ho, MD, Giuseppe Tarantini, MD, Jola Xhaxho, MD, Mark Weston, MD, Ashkan Ehdaie, MD, LeRoy Rabbani, MD, and Ajay J. Kirtane, MD

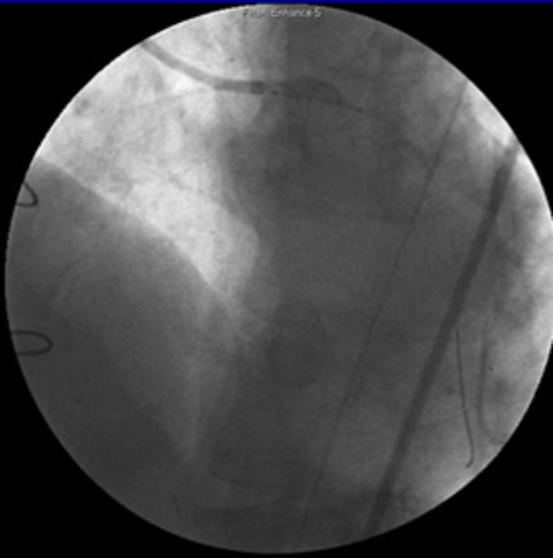
The present study evaluated the safety and efficacy of percutaneous coronary intervention (PCI) of the unprotected left main coronary artery (ULMCA) for the treatment of cardiac allograft vasculopathy (CAV) in consecutive unselected patients with orthotopic heart transplantation (OHT). PCI in patients with OHT with CAV has been associated with greater restenosis rates compared to PCI in patients with native coronary artery disease. A paucity of short- and long-term data is available from patients with OHT who have undergone PCI for ULMCA disease. The present retrospective, multicenter, international registry included 21 patients with OHT and CAV who underwent ULMCA PCI from 1997 to 2009. Angiographic success was achieved in all patients. Drug-eluting stents were used in 14 of the 21 patients. No major adverse cardiac events or repeat OHT occurred within the first 30 days. At a mean follow-up of 4.9 ± 3.2 years, 3 patients (14%) had died, myocardial infarction had occurred in 1 patient (5%), and target lesion revascularization had been required in 4 patients (19%). Follow-up angiography was performed in 16 patients (76%), and restenosis was observed in 4 (19%). No stent thrombosis of the ULMCA was observed. One patient (5%) underwent coronary artery bypass grafting, and 5 patients (24%) underwent repeat OHT. In conclusion, the results of our study have shown ULMCA PCI to be safe and reasonably effective in patients with OHT and represents a viable treatment strategy for CAV in these patients. (Am J Cardiol 2010;xx:xxx)

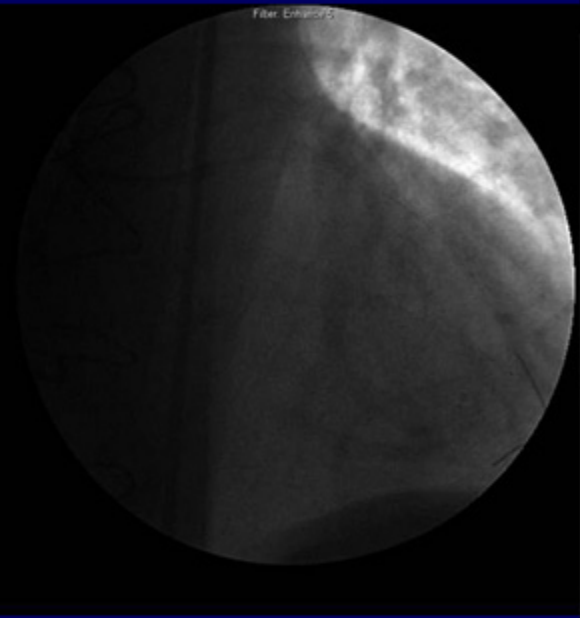
Kaplan-Meier analysis of survival and major adverse cardiac event-free survival

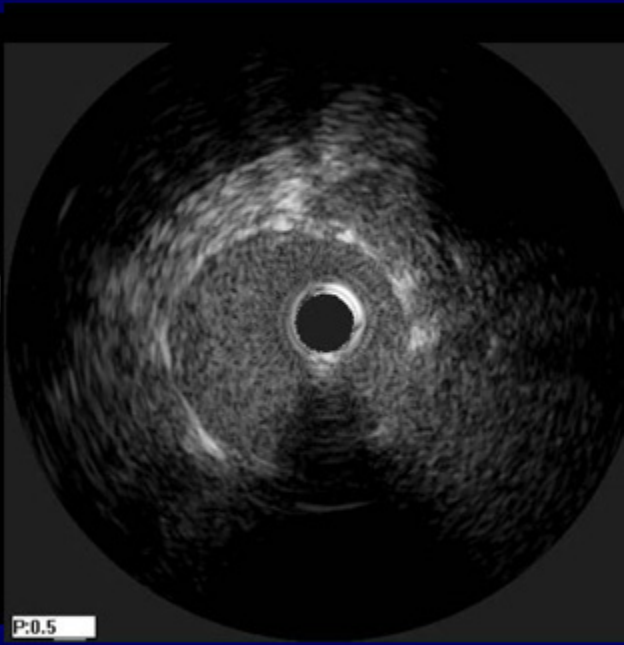


Lee MS, et al. Am J Cardiol 2010


Filter Enhance 5


Filter Enhance 5


Fiber Enhanced


P:0.5

Catheterization and Cardiovascular Interventions 00:000–000 (2010)

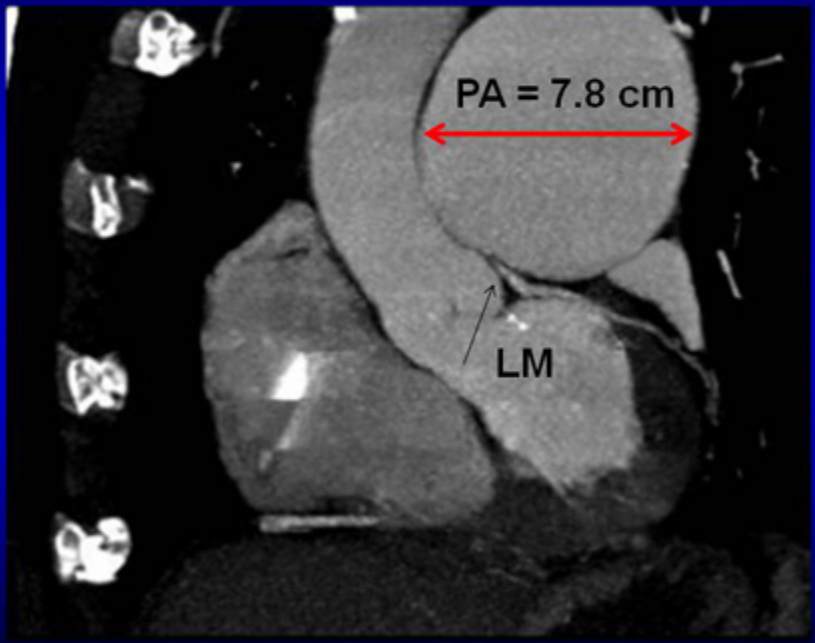
Interventional Rounds

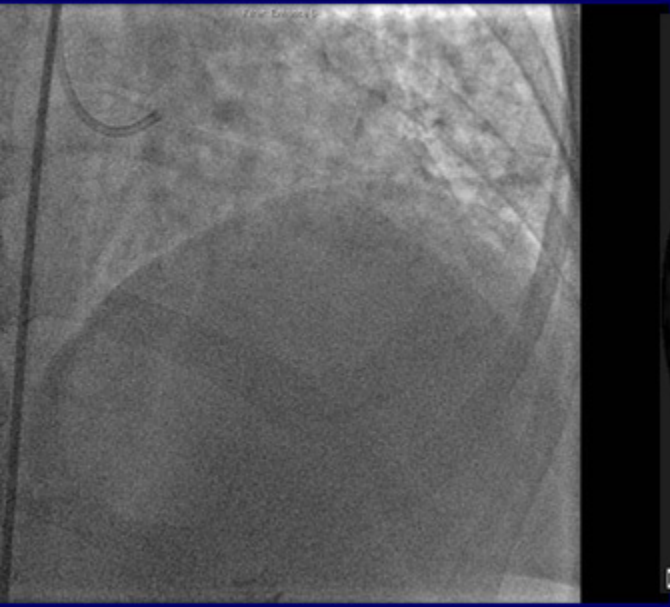
Left Main Coronary Artery Compression from Pulmonary Artery Enlargement Due to Pulmonary Hypertension: A Contemporary Review and Argument for Percutaneous Revascularization

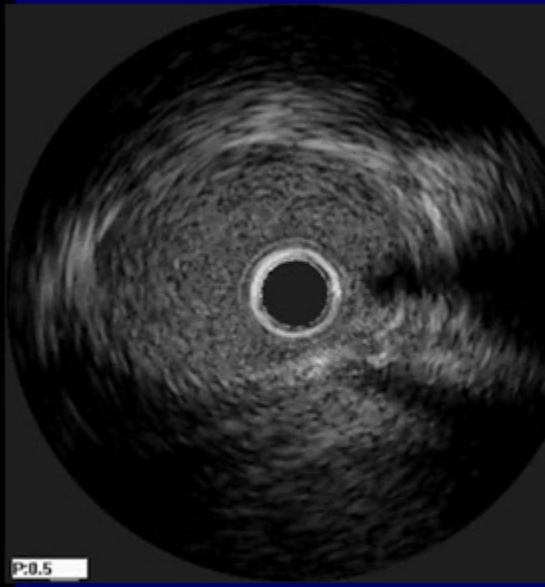
Michael S. Lee,[1*] MD, Jared Oyama,[1] MD, Ravi Bhatia,[2] MD, Young-Hak Kim,[3] MD, and Seung-Jung Park,[3] MD

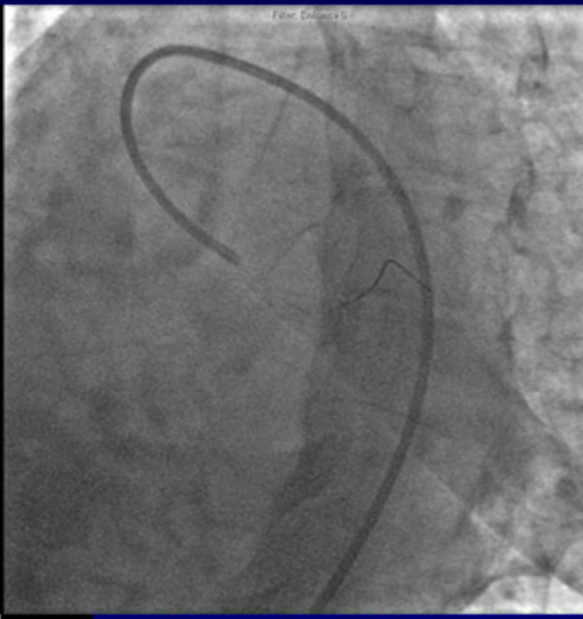
Extrinsic compression of the left main coronary artery by an enlarged pulmonary artery is an increasingly recognized and potentially reversible cause of angina and left ventricular dysfunction in patients with pulmonary hypertension. The diagnosis of extrinsic left main coronary artery compression requires a high index of suspicion and should be considered in patients with severe pulmonary hypertension who experience angina. Coronary angiography with intravascular ultrasound is the gold standard for diagnosis of this condition, though cardiac computed tomography and magnetic resonance angiography allow for noninvasive means of screening. The optimal treatment is debatable, but percutaneous coronary intervention appears to be a feasible, safe, and effective treatment option for patients with extrinsic compression of the left main coronary artery from pulmonary artery enlargement. Given the high risk of postoperative right ventricular failure and mortality observed with surgical revascularization in these patients, we recommend that physicians recognize percutaneous coronary intervention as the preferred revascularization strategy for selected patients with extrinsic compression of the left main coronary artery due to pulmonary hypertension.

Left Main Compression from Pulmonary Artery Aneurysm

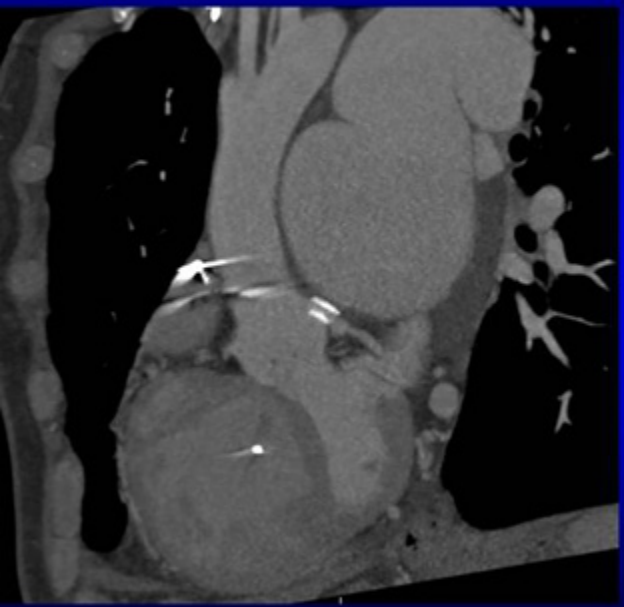


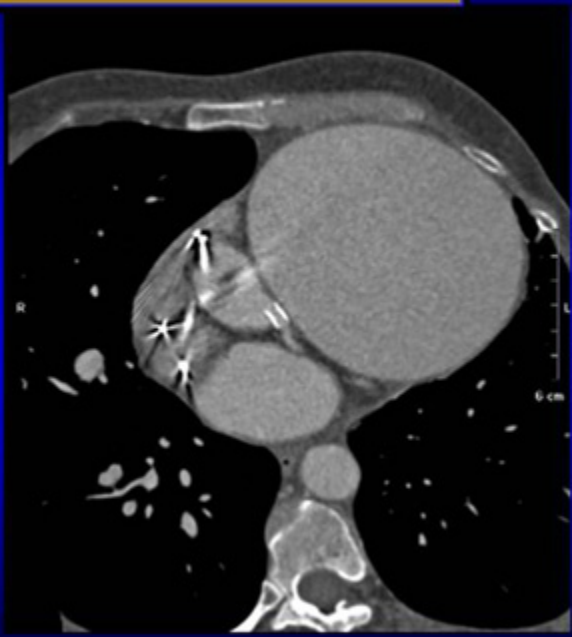



P:0.5

6-month CT Angiography





STATE-OF-THE-ART PAPER

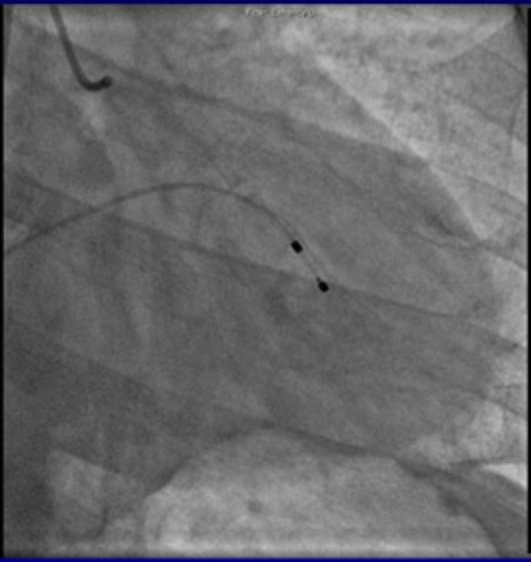
Unprotected Left Main Coronary Disease and ST-Segment Elevation Myocardial Infarction

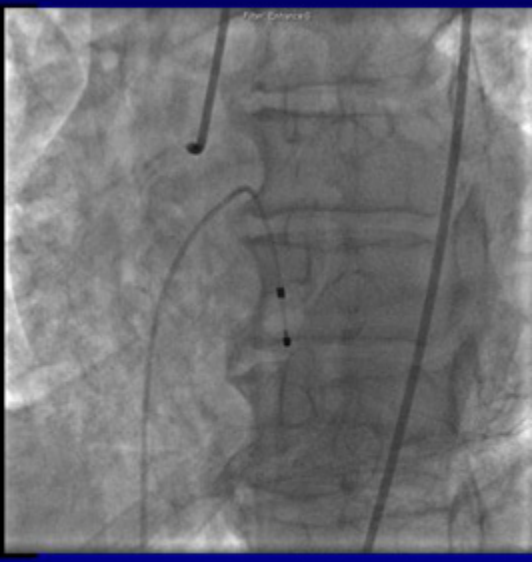
A Contemporary Review and Argument for Percutaneous Coronary Intervention

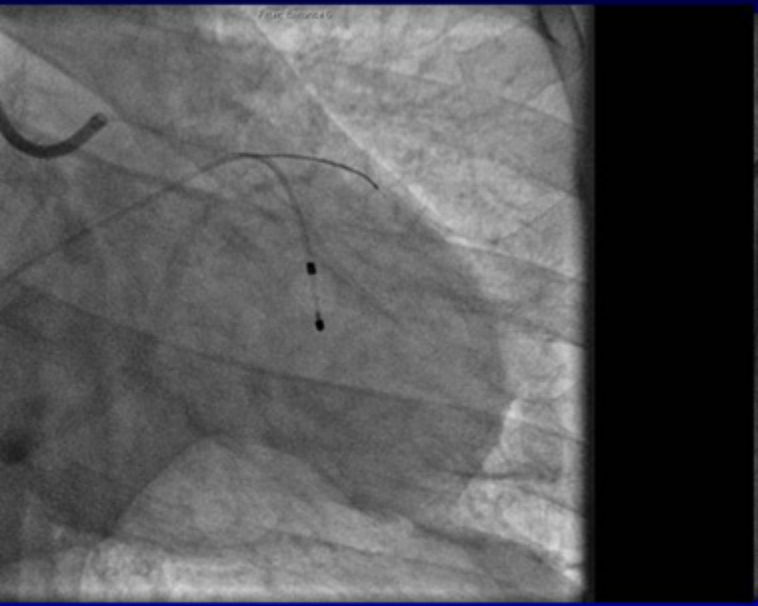
Michael S. Lee, MD,* Pooya Bokhoor, MD,* Seung-Jung Park, MD,† Young-Hak Kim, MD,†
Gregg W. Stone, MD,‡ Imad Sheiban, MD,§ Giuseppe Biondi-Zoccai, MD,§
Dario Sillano, MD,§ Jonathan Tobis, MD,* David E. Kandzari, MD‖

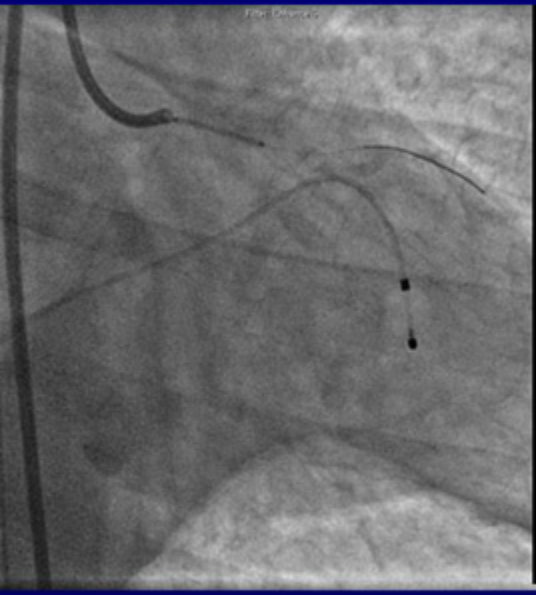
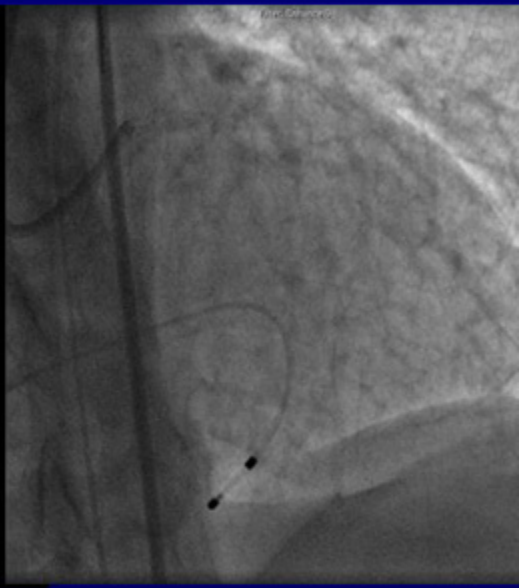
Los Angeles and La Jolla, California; Seoul, South Korea; New York, New York; and Turin, Italy

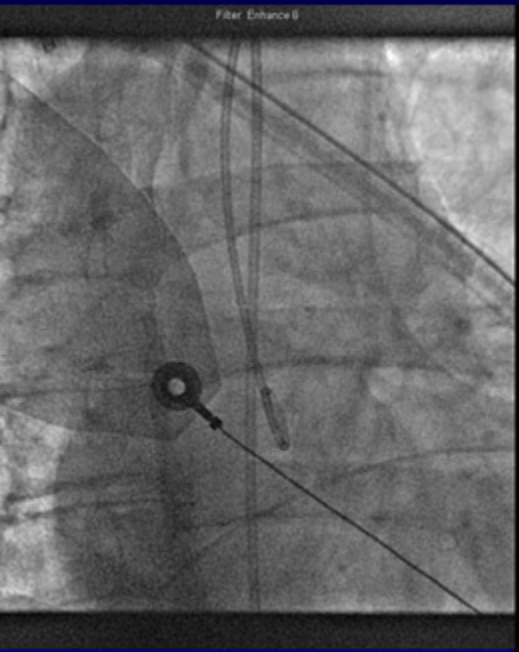
Acute occlusion involving the unprotected left main coronary artery (ULMCA) is a clinically catastrophic event, often leading to abrupt and severe circulatory failure, lethal arrhythmias, and sudden cardiac death. Although coronary artery bypass grafting (CABG) is the standard of care for ULMCA disease in patients with stable ischemic heart disease, uncertainty surrounds the optimal revascularization strategy for patients with ST-elevation myocardial infarction (MI) and ULMCA occlusion who survive to hospitalization, and treatment guidelines in this setting are vague. Percutaneous coronary intervention (PCI) is technically feasible in most patients, has the advantage of providing more rapid reperfusion compared with CABG with acceptable short- and long-term outcomes, and is associated with a lower risk of stroke. PCI of the ULMCA should be considered as a viable alternative to CABG for selected patients with MI, including those with ULMCA occlusion and less than Thrombolysis In Myocardial Infarction flow grade 3, cardiogenic shock, persistent ventricular arrhythmias, and significant comorbidities. The higher risk of target vessel revascularization associated with ULMCA PCI compared with CABG is an acceptable tradeoff given the primary need for rapid reperfusion to enhance survival. (J Am Coll Cardiol Intv 2010;3:791–5)



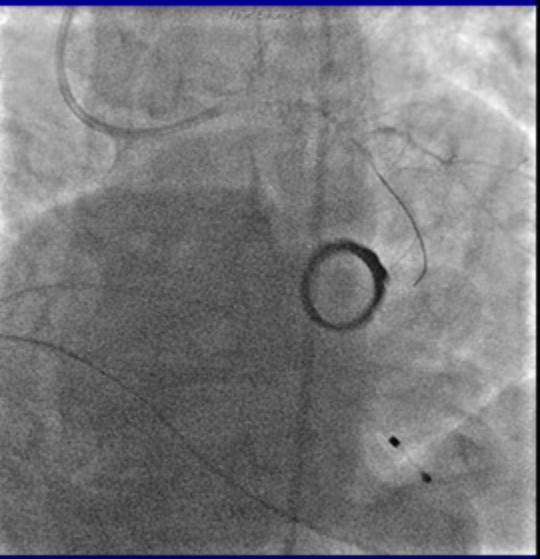


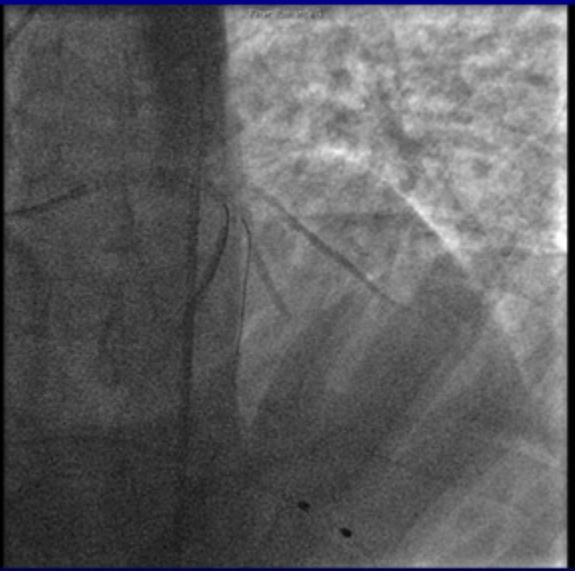


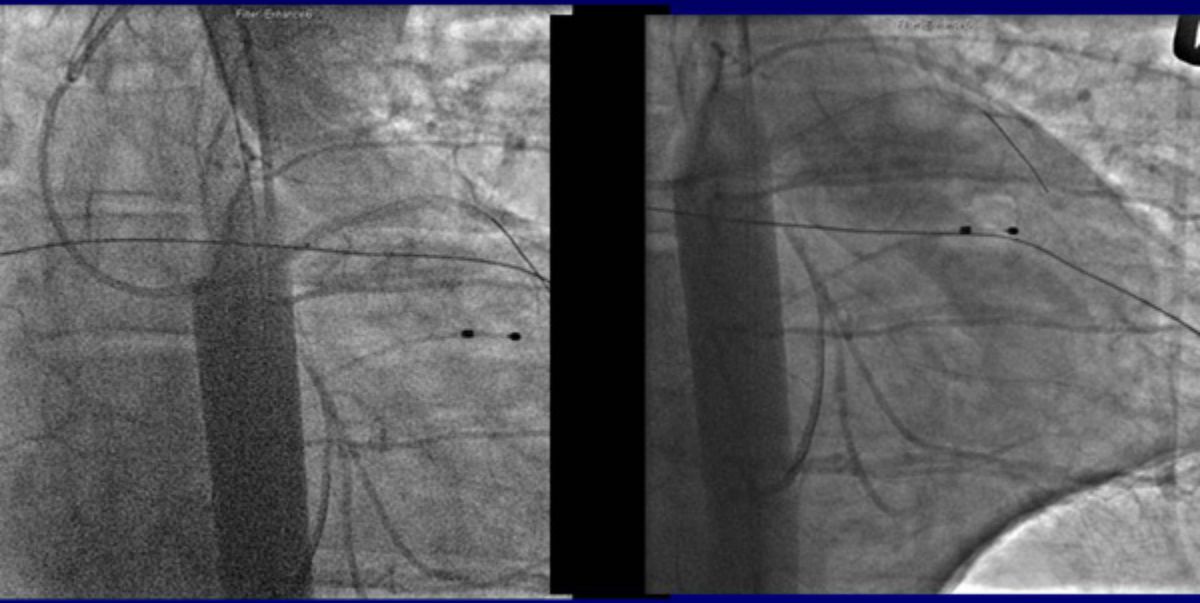



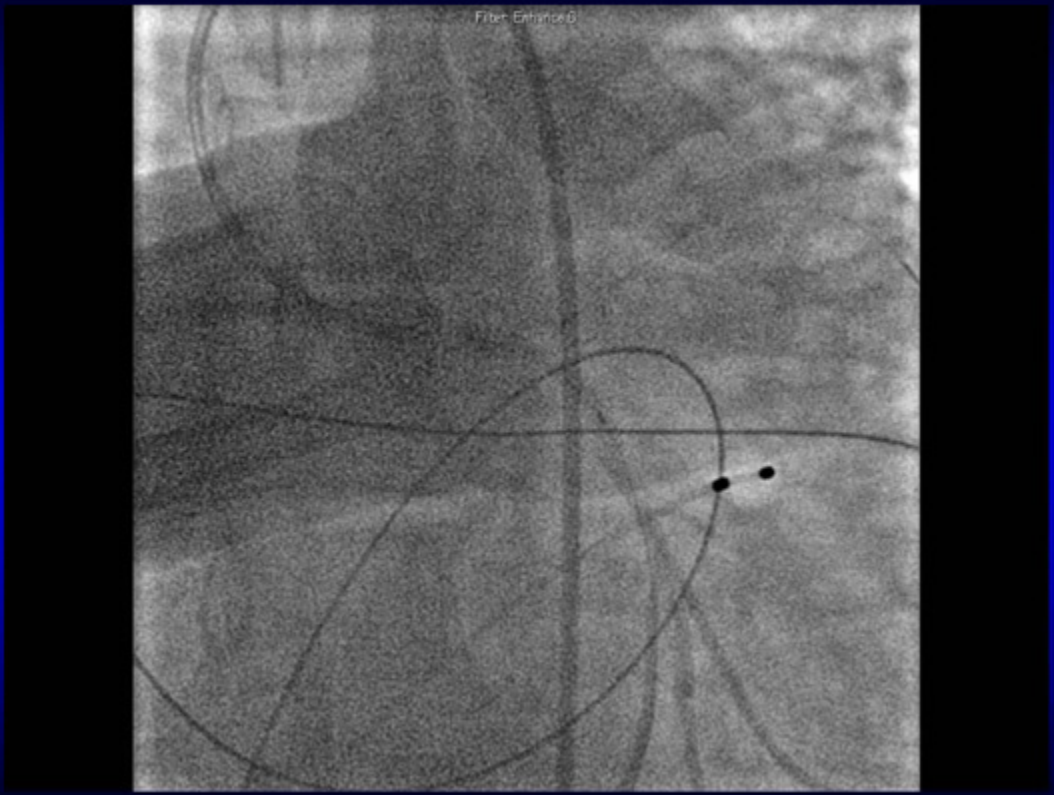

Filter: Enhance 6

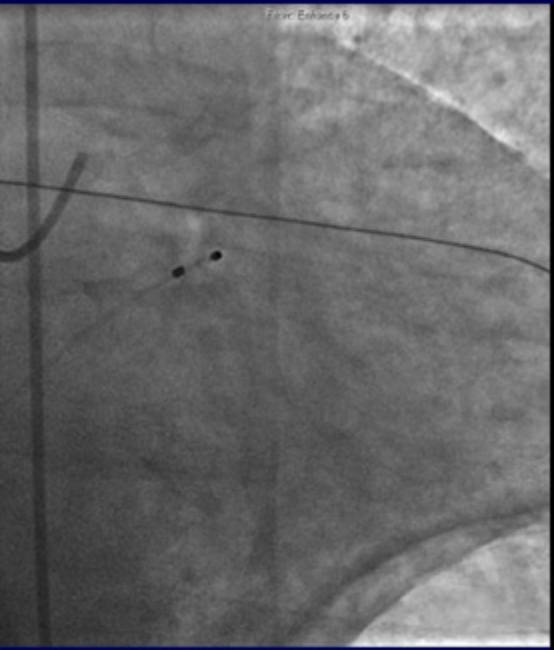

Filter: Enhance 6







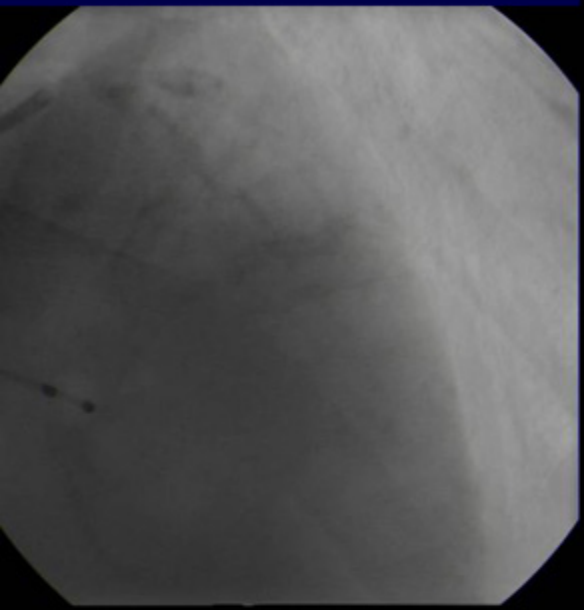
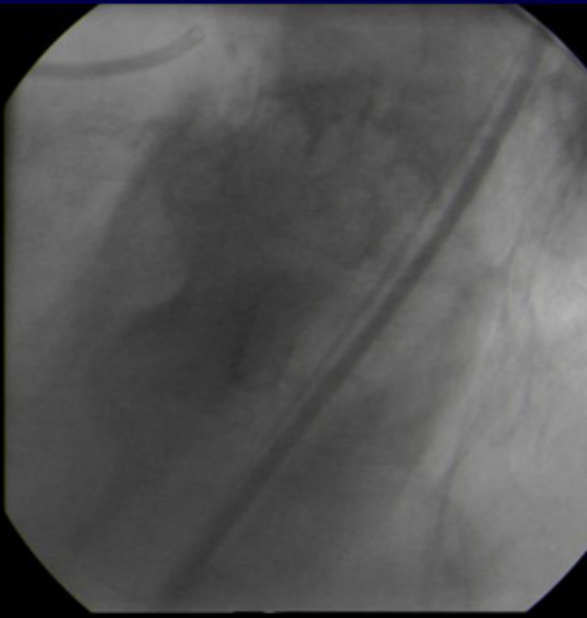

Fiber Entrance 0

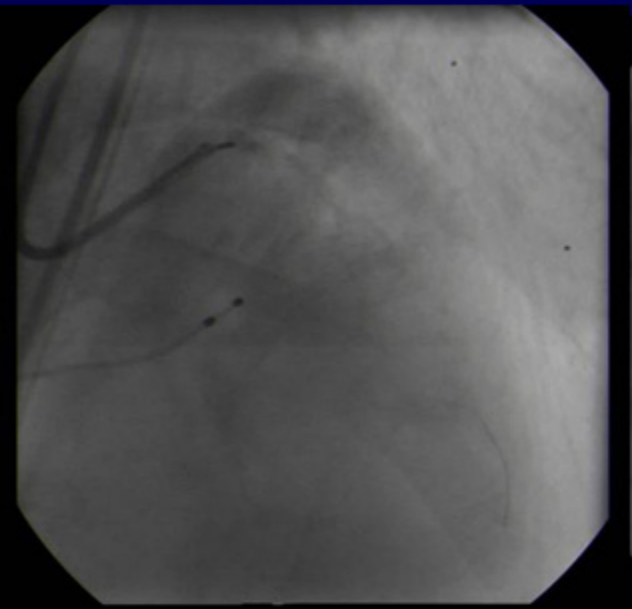
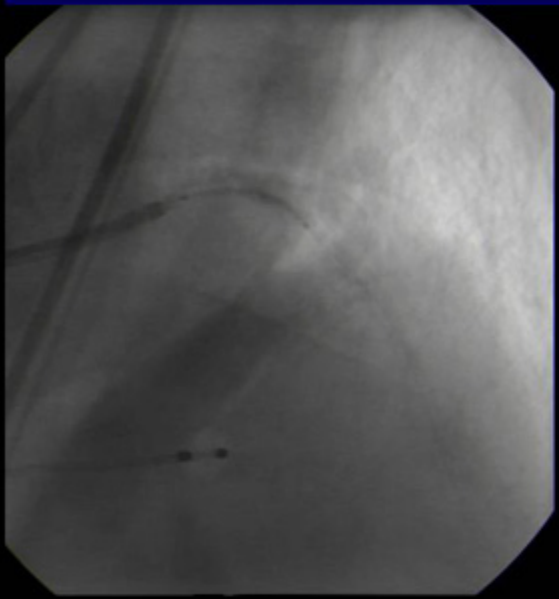

Fine Enhance

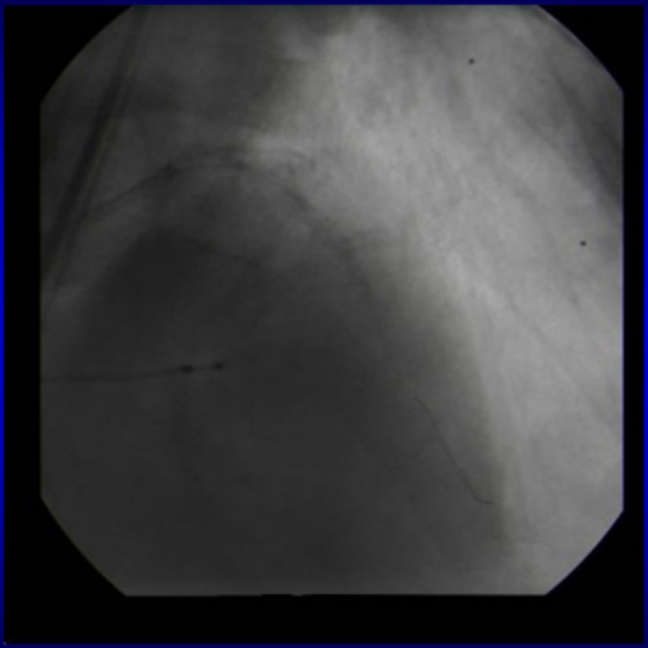

Fine Enhance

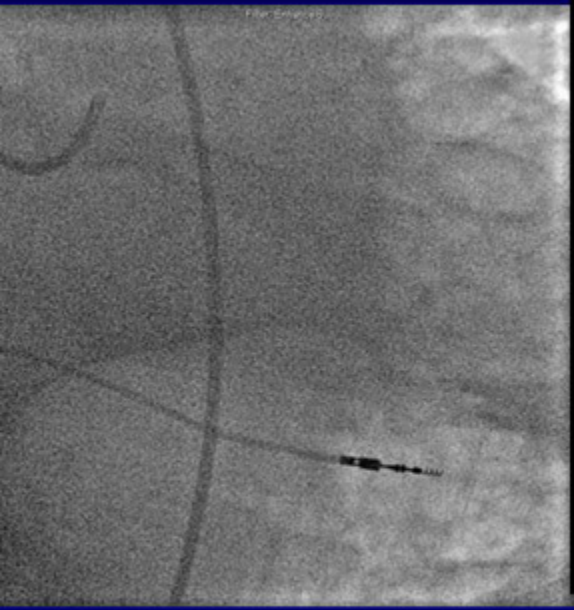
Hemodynamic Support

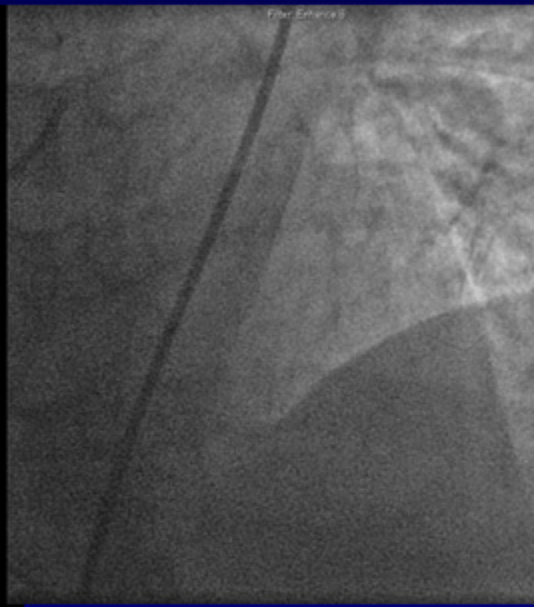
- SBP <100 mmHg
- Presentation with acute coronary syndrome
- Arrhythmic instability
- Severe LV dysfunction (EF <25%)
- Presentation with decompensated HF
- Dominant LCX
- Occluded dominant RCA
- Atherectomy

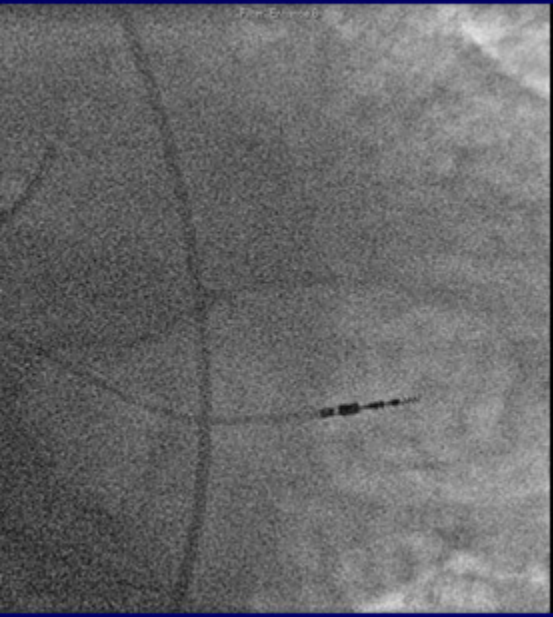



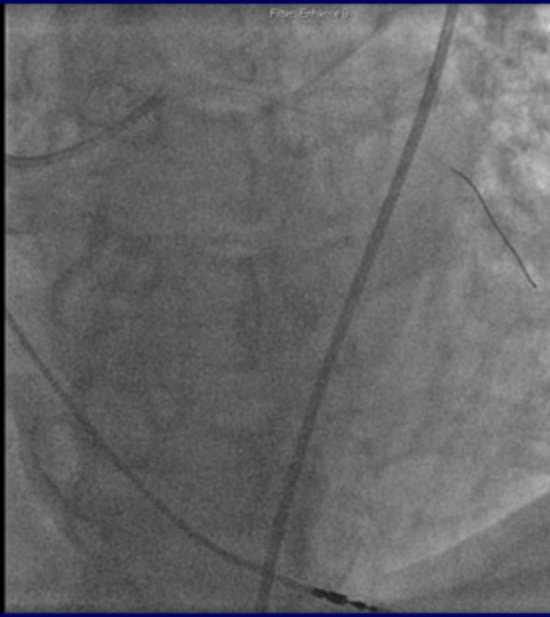






Filter Entrance


Filter Entrance





Lesion Assessment

TABLE IV. Comparison Between IVUS and FFR for Assessment of ULM Disease

	IVUS	FFR
Type of lesion assessment	Anatomic	Hemodynamic
Abnormal value	MLA <6.0 mm^2	<0.80
Characterization of plaque morphology	Yes	No
Characterization of plaque distribution	Yes	No
Stent diameter and length sizing	Yes	No
Post-PCI stent expansion	Yes	No
Post-PCI stent apposition	Yes	No
Post-PCI side-branch compromise	Yes	Yes
Post-PCI dissection	Yes	No

FFR = fractional flow reserve; IVUS = intravascular ultrasound; MLA = minimal luminal area; PCI = percutaneous coronary intervention.

Impact of IVUS on Late Outcomes Following UPLM PCI
3 Year MAIN COMPARE Trial

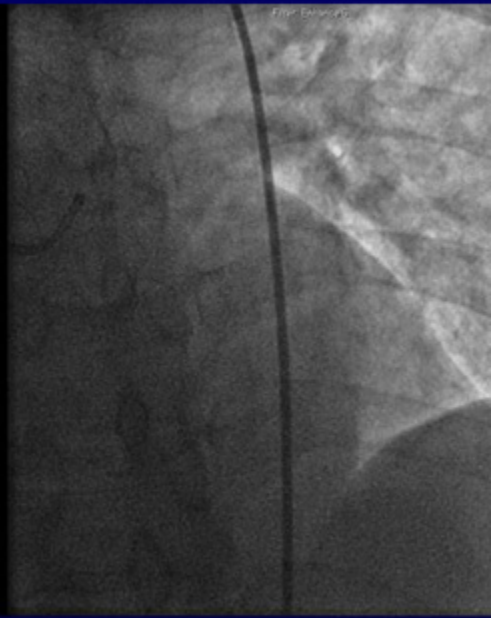
145 Propensity Matched Pairs

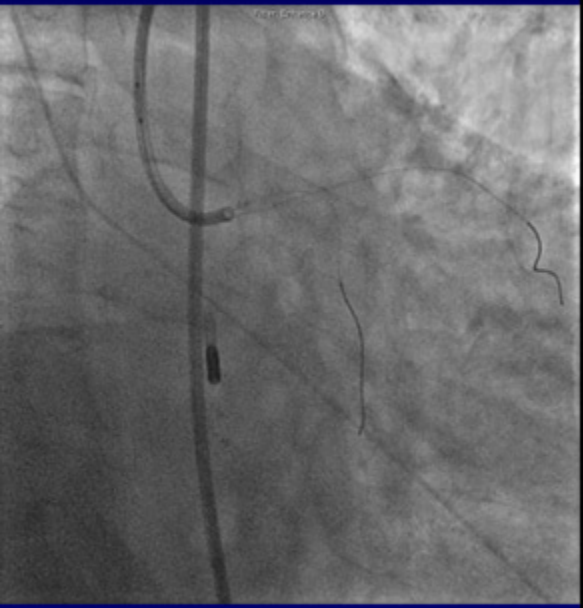
	IVUS	Angiography	*P* value
Death	4.7%	16.0%	0.049
Death or MI	13.6%	26.8%	0.084
TVR	7.1%	9.6%	0.62

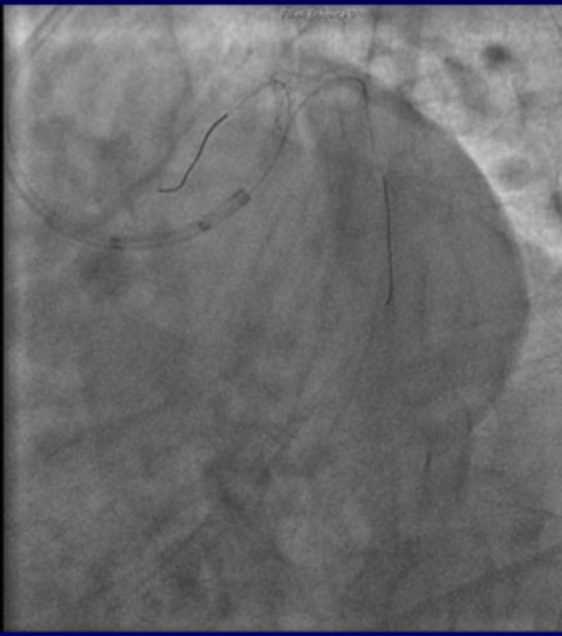
Park et al., Circ Cardiovasc Intervent 2009

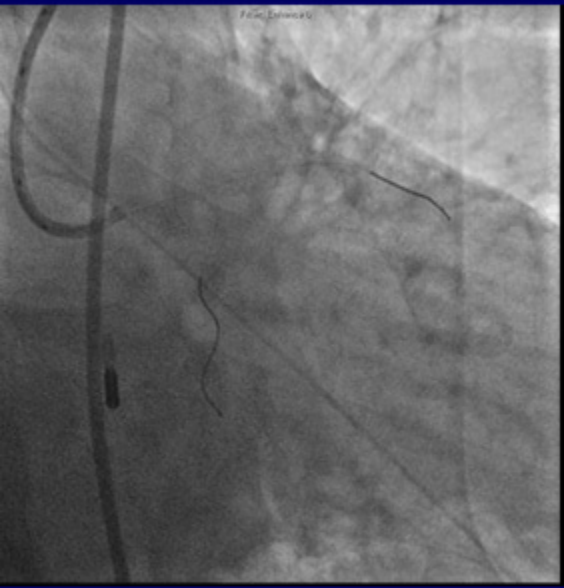
Procedural and Stent Technique

- PCI from distal to proximal
- Consider proximal to distal if the LMCA is critically diseased or clinical instability

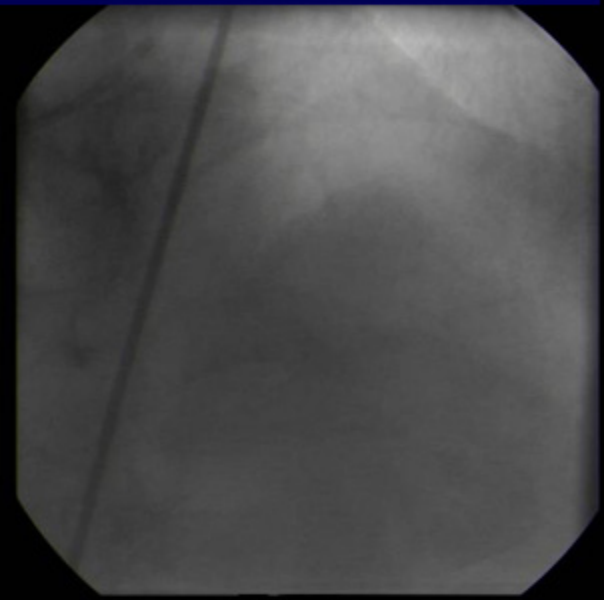


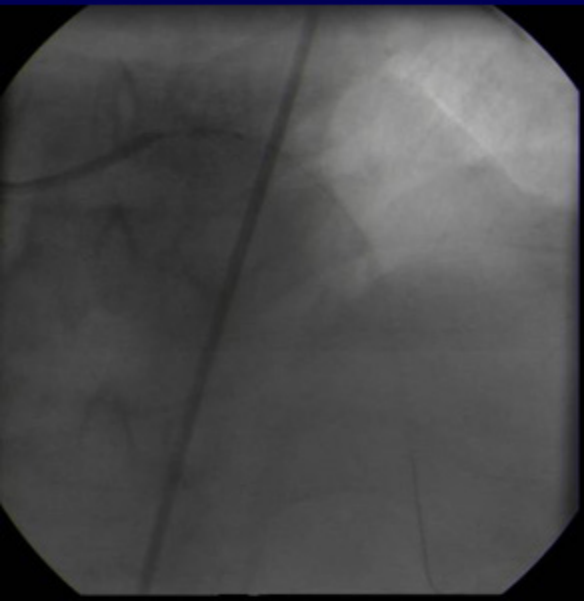






Ostial and Shaft Lesions

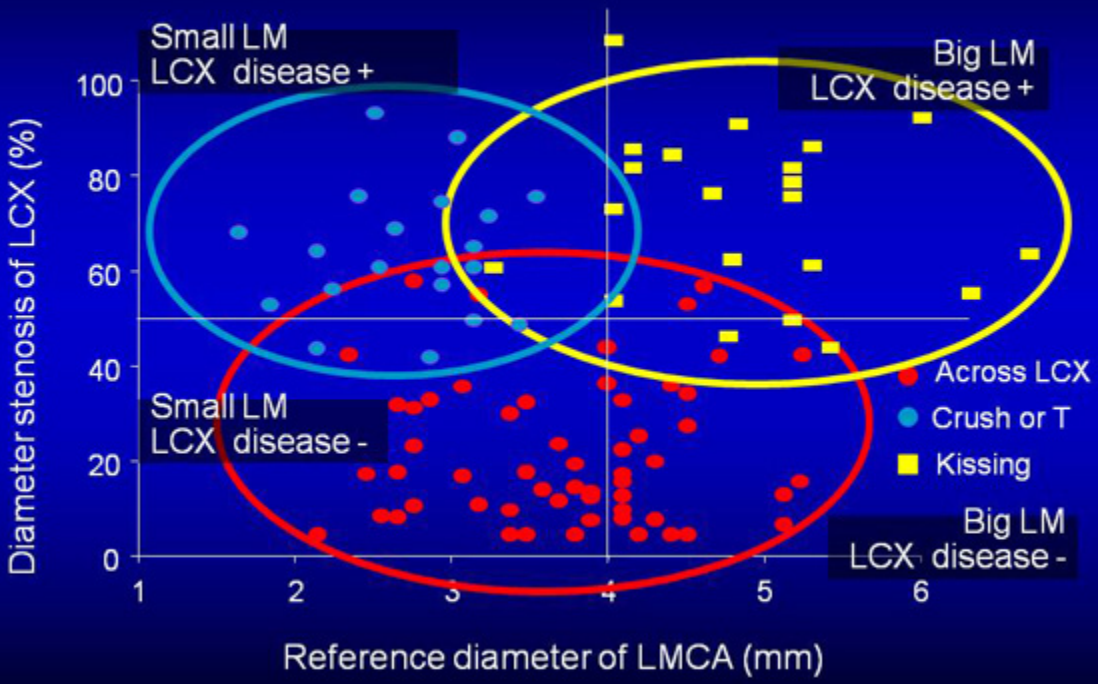


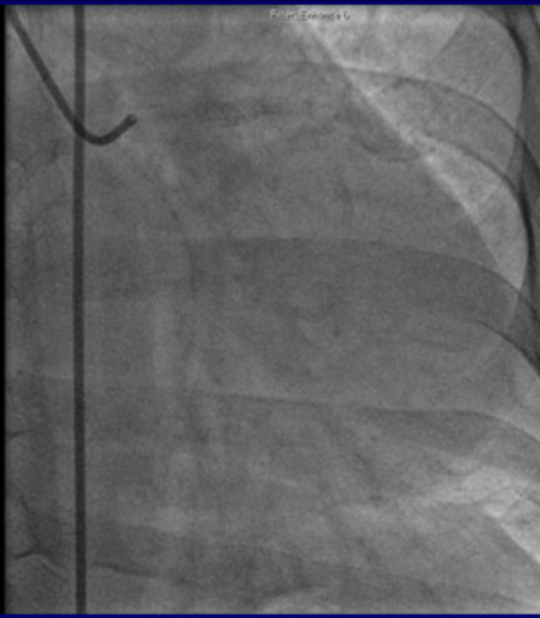

Bifurcation Disease

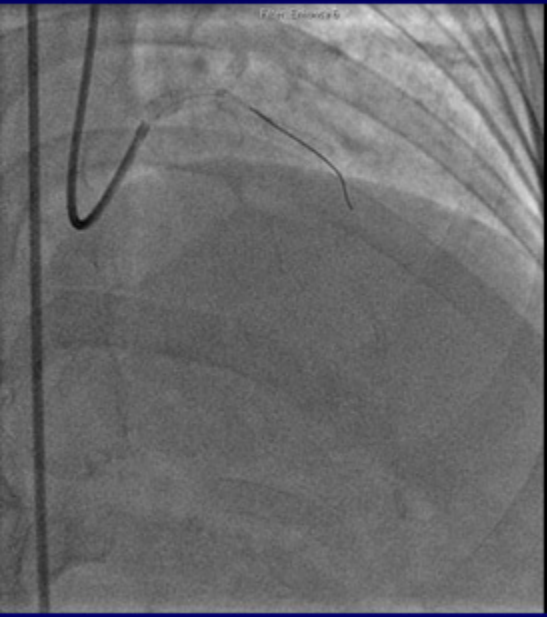
Stenting Techniques for Bifurcation Disease

according to LM size and LCX ostial stenosis

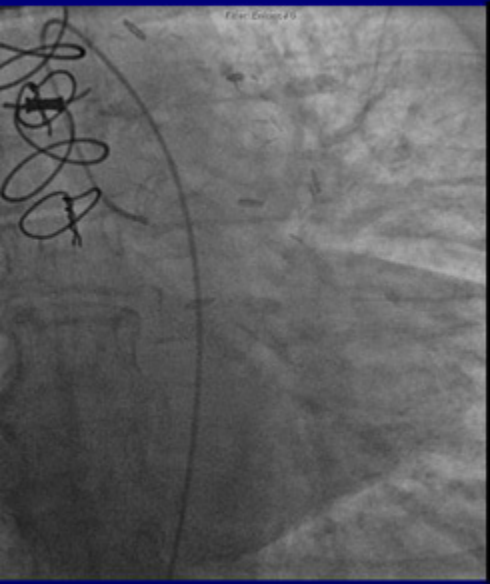


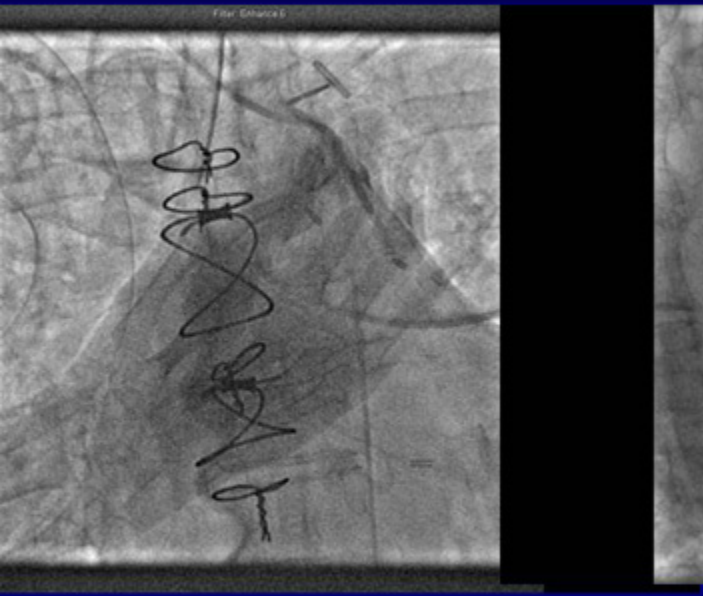
Single Stent Technique



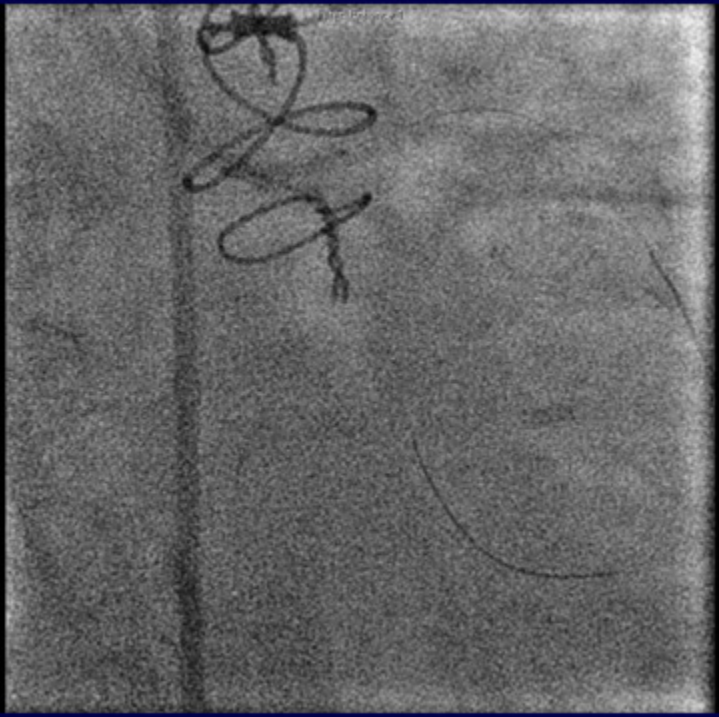


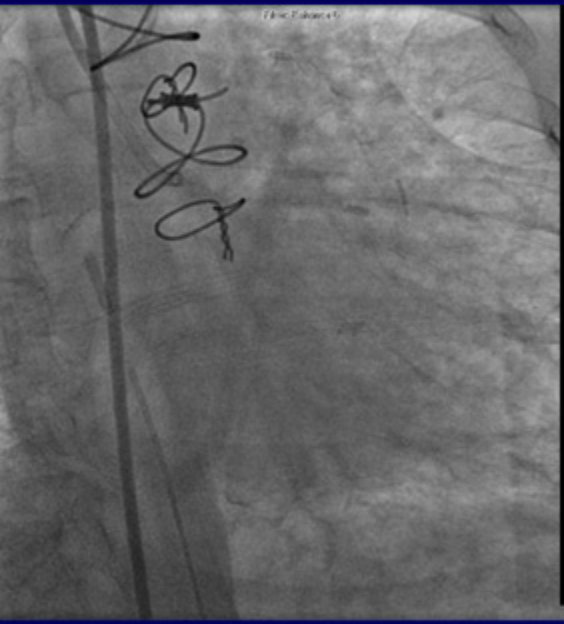
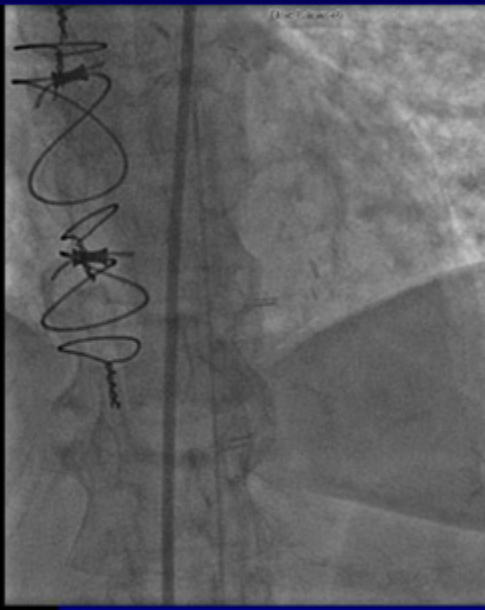
2-Stent Technique




Filter Enhance5


Filter Enhance5

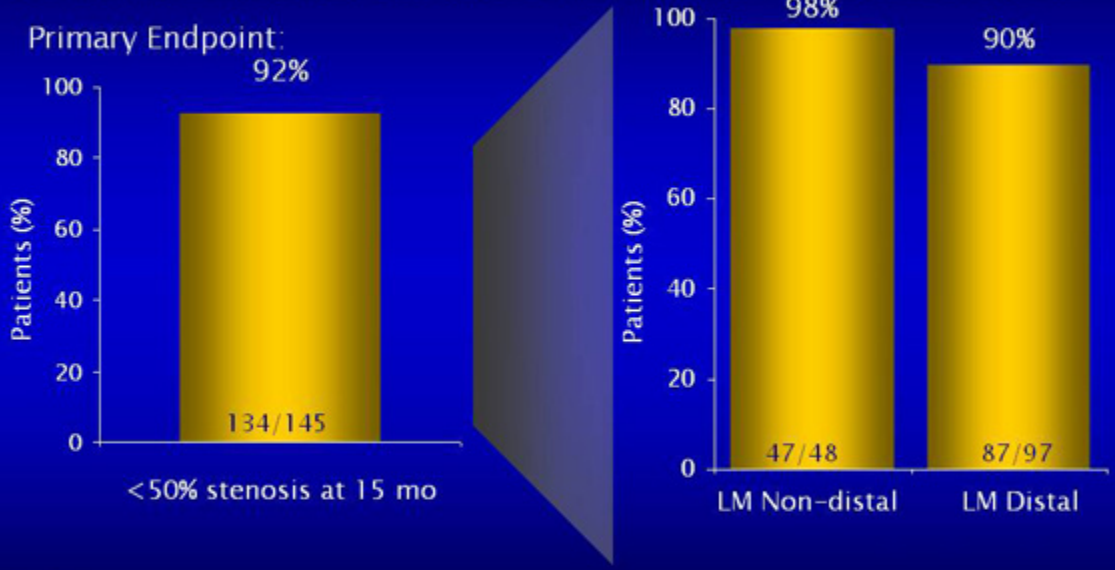


Treatment of ULMCA Restenosis

SYNTAX-LE MANS Principal Results
Taxus Express Stent Cohort

Rate of long-term patency of treated left main lesion(s) by QCA at 15 months



Definitions:
Diameter stenosis was assessed by QCA

Presented by Dr. A. Pieter Kappetein, EuroPCR 2009

Incidence and Management of Restenosis After Treatment of Unprotected Left Main Disease With Drug-Eluting Stents

70 Restenotic Cases From a Cohort of 718 Patients: FAILS (Failure in Left Main Study)

Imad Sheiban, MD,* Dario Sillano, MD,* Giuseppe Biondi-Zoccai, MD,* Alaide Chieffo, MD,† Antonio Colombo, MD,† Sabine Vecchio, MD,‡ Massimo Margheri, MD,‡ Julian P. Gunn, MD,§ Tushar Raina, MD,§ Francesco Liistro, MD,‖ Leonardo Bolognese, MD,‖ Michael S. Lee, MD,¶ Jonathan Tobis, MD,¶ Claudio Moretti, MD, PHD*

Turin, Milan, Ravenna, and Arezzo, Italy; Sheffield, United Kingdom; and Los Angeles, California

Objectives This study sought to retrospectively appraise the incidence and management of restenosis after drug-eluting stent (DES) implantation for unprotected left main (ULM) disease.

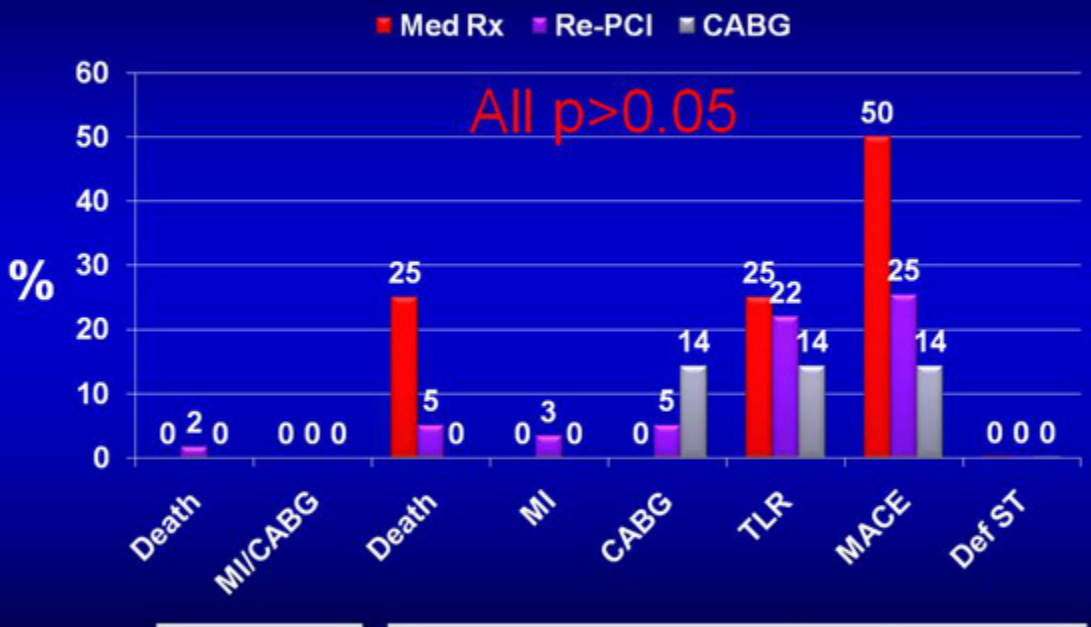
Background The promising role of DES for ULM has been reported. However, no detailed data are available on subsequent restenosis.

Methods From the total sample of patients with ULM treated with DES, we identified those presenting with angiographic ULM restenosis. The primary end point was the long-term rate of major adverse cardiac events (MACE), that is, death, myocardial infarction (MI), or target lesion revascularization (TLR). We also adjudicated stent thrombosis according to the Academic Research Consortium.

Results Post-DES restenosis in ULM occurred in 70 of 718 patients (9.7%). Of these, 59 (84.3%) were treated percutaneously (34 [48.6%] with additional DES, 22 [31.4%] with standard or cutting balloons, 2 [2.9%] with rotational atherectomy, and 1 [1.4%] with a bare-metal stent), whereas 7 (10%) patients underwent bypass surgery and 4 (5.7%) were treated medically. In-hospital MACE included no periprocedural MI and only 1 (1.4%) death. After 27.2 ± 15.4 months, MACE occurred cumulatively in 18 (25.7%) patients, with death in 4 (5.7%), MI in 2 (2.9%), and TLR in 15 (21.4%). Patients treated with medical, interventional, and surgical therapy had the following MACE rates, respectively: 50%, 25.4%, and 14.3%. Definite, probable, and possible stent thrombosis occurred in 0 (0%), 1 (1.4%), and 1 (1.4%) patient, respectively.

Conclusions DES restenosis in the ULM artery can be managed in most cases with a minimally invasive approach, achieving favorable early and late results. (*J Am Coll Cardiol* 2009;54:1131–6) © 2009 by the American College of Cardiology Foundation

CLINICAL OUTCOMES



Incidence, Predictors, Treatment, and Long-Term Prognosis of Patients With Restenosis After Drug-Eluting Stent Implantation for Unprotected Left Main Coronary Artery Disease

Jong-Young Lee, MD,* Duk-Woo Park, MD, PhD,* Young-Hak Kim, MD, PhD,*
Sung-Cheol Yun, PhD,† Won-Jang Kim, MD, PhD,* Soo-Jin Kang, MD, PhD,*
Seung-Whan Lee, MD, PhD,* Cheol-Whan Lee, MD, PhD,* Seong-Wook Park, MD, PhD,*
Seung-Jung Park, MD, PhD*

Seoul, Korea

Objectives The aim of this study was to evaluate the incidence, predictors, and long-term outcomes of patients with in-stent restenosis (ISR) after percutaneous coronary intervention (PCI) with drug-eluting stents (DES) for unprotected left main coronary artery (LMCA) disease.

Background Few data on the clinical course and management of patients experiencing restenosis after DES treatment for unprotected LMCA disease have appeared.

Methods Between February 2003 and November 2007, 509 consecutive patients with unprotected LMCA disease underwent DES implantation, with 402 (80.1%) undergoing routine surveillance or clinically driven angiographic follow-up. A major adverse cardiac event was defined as the composite of death, myocardial infarction (MI), or target-lesion revascularization.

Results The overall incidence of angiographic ISR in LMCA lesions was 17.6% (71 of 402 patients, 57 with focal-type and 14 with diffuse-type ISR. Forty patients (56.3%) underwent repeated PCI, 10 (14.1%) underwent bypass surgery, and 21 (29.6%) were treated medically. During long-term follow-up (a median of 31.7 months), there were no deaths, 1 (2.2%) MI, and 6 (9.5%) repeated target-lesion revascularization cases. The incidence of major adverse cardiac event was 14.4% in the medical group, 13.6% in the repeated PCI group, and 10.0% in the bypass surgery group ($p = 0.91$). Multivariate analysis showed that the occurrence of DES-ISR did not affect the risk of death or MI.

Conclusions The incidence of ISR was 17.7% after DES stenting for LMCA. The long-term clinical prognosis of patients with DES-ISR associated with LMCA stenting might be benign, given that these patients were optimally treated with the clinical judgment of the treating physician. (J Am Coll Cardiol 2011;57:1349–58) © 2011 by the American College of Cardiology Foundation

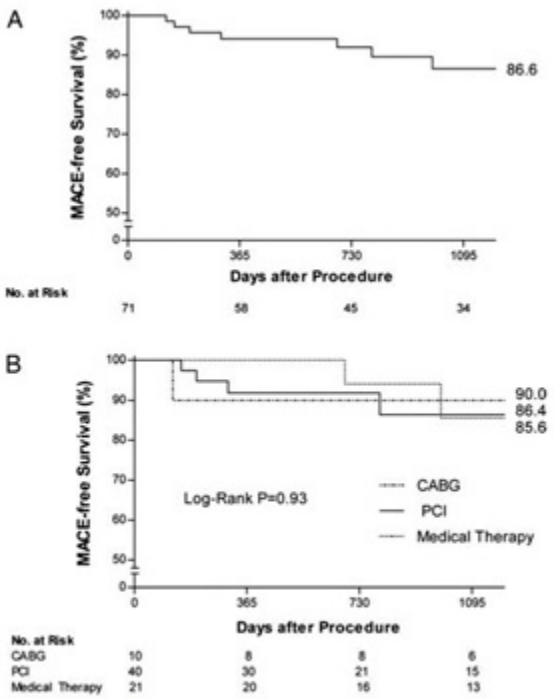


Figure 4 **Long-Term Clinical Outcomes of In-Stent Restenosis**

(A) Kaplan-Meier analysis of event-free survival after major adverse cardiac events (MACE) in patients with overall left main in-stent restenosis. **(B)** Kaplan-Meier analysis of event-free survival after MACE in patients with left main in-stent restenosis according to treatment strategy (medical vs. repeated percutaneous coronary intervention [PCI] vs. coronary artery bypass grafting [CABG]).