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TCT Asia Pacific 2019, Seoul, South Korea
April 29th | 11:58-12:06 pm

24th CARDIOVASCULAR SUMMIT
TCTAP2019
April 27-30, 2019, Coex, Seoul, Korea

Hybrid Coronary Revascularization: Clinical Data and Future Perspectives

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Founding Editor: *JACC Cardiovascular Interventions*



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I, Spencer B. King III DO NOT have a financial interest/arrangement or affiliation with one or more organizations that could be perceived as a real or apparent conflict of interest in the context of the subject of this presentation.

State of Coronary Revascularization

2nd gen DES and new stent platforms
have made considerable **improvements**
in PCI outcomes

However

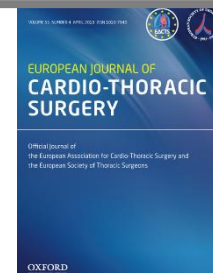
LIMA to LAD graft
has the **best long term survival advantage**

Contemporary Left Main CABG vs PCI Trials

Left Main PCI vs CABG trials	CABG (total patients)	PCI arm (total patients)	LM Bifurcation (total patients)	Syntax Score	Type of DES	Follow up (years)	TLR (%)	TVR (%)	MACE (%)	Conclusion
1st Gen. DES										
SYNTAX LM ²	348	357	56	< 22	PES	5	5-years: 23%		5 years: PCI vs. CABG: 32% vs. 28.6% (p= 0.12)	PCI equivalent
2nd Gen. DES										
PRECOMBAT 2 ²⁰	272	334	240	< 26	EES	1,5		PCI vs CABG: 6.5% vs. 2.6 % (P= 0.02)	PCI vs. CABG: 8.9 % vs. 6.7 % (P= 0.26)	PCI equivalent
EXCEL ⁶	957	948	767 (81%)	< 32	EES	3	ID-TLR PCI: 12.60% CABG: 7.50%		Death, stroke, or MI: 30-days: PCI: 4.9 % CABG: 7.9 % 3-years: PCI: 15.4 % CABG: 14.7 %	PCI non-inferior
NOBLE ⁷	592	592	479 (81%)	Median: 22.5	Biolimus	5	PCI: 12% CABG: 8%		Death 30-days PCI: 0.34% CABG: 1.2% Death, MI, CVA, TLR 5-years PCI: 28.9% CABG: 19.1%	PCI inferior due to increased MI and stroke rates

While TLR rates have decreased side branch stenosis is still a problem and long term outcomes are unknown.

Revascularization in left main coronary artery disease: comparison of off-pump coronary artery bypass grafting vs percutaneous coronary intervention[†]



Patients with LMCA disease were treated with OPCAB (n = 553) or PCI (n = 346). We compared major adverse cardiac and cerebrovascular events (MACCE) including death, stroke, acute MI and TVR. The median follow-up was 55.9 months.

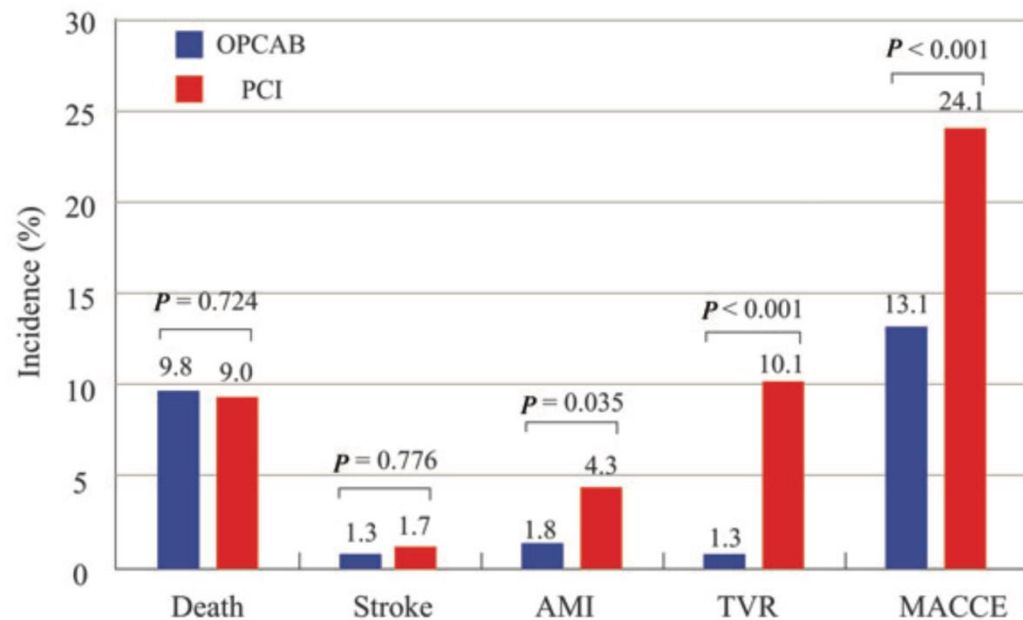
Table 3: Bifurcation lesions of left main coronary artery

Variables	PCI group	OPCAB group	P value
Bifurcation lesions	173/346 (50.0%)	132/284 (46.5%)	0.244
MEDINA classification			
1.0.0	16 (9.2%)	6 (4.5%)	0.119
0.1.0	5 (2.9%)	5 (3.8%)	0.656
1.1.0	53 (30.5%)	31 (23.5%)	0.176
1.1.1	78 (44.8%)	79 (59.8%)	0.009
0.0.1	5 (2.9%)	2 (1.5%)	0.479
1.0.1	14 (8.0%)	5 (3.8%)	0.126
0.1.1	3 (1.7%)	4 (3.0%)	0.703

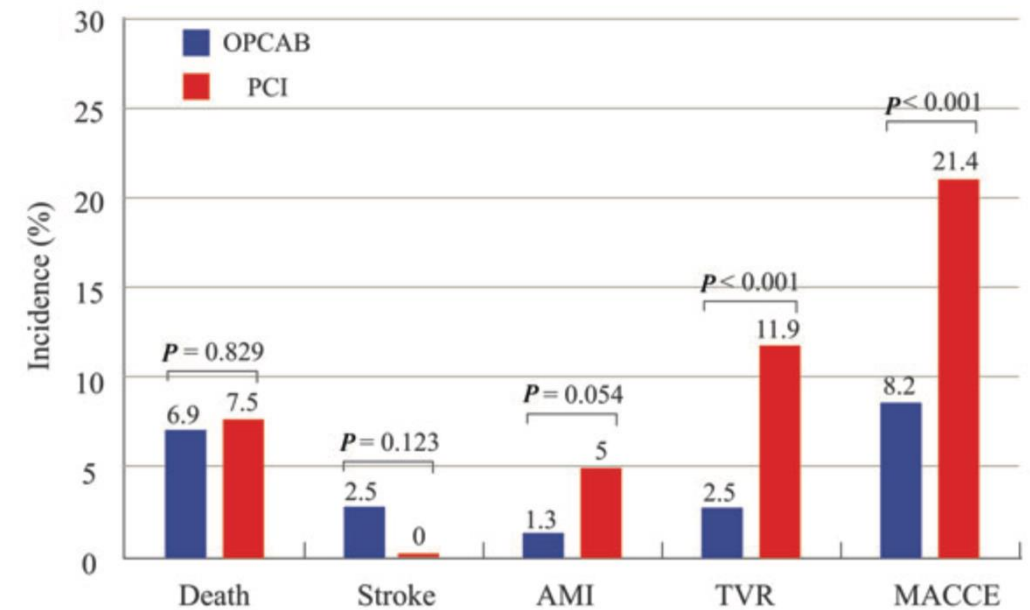
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Overall Population



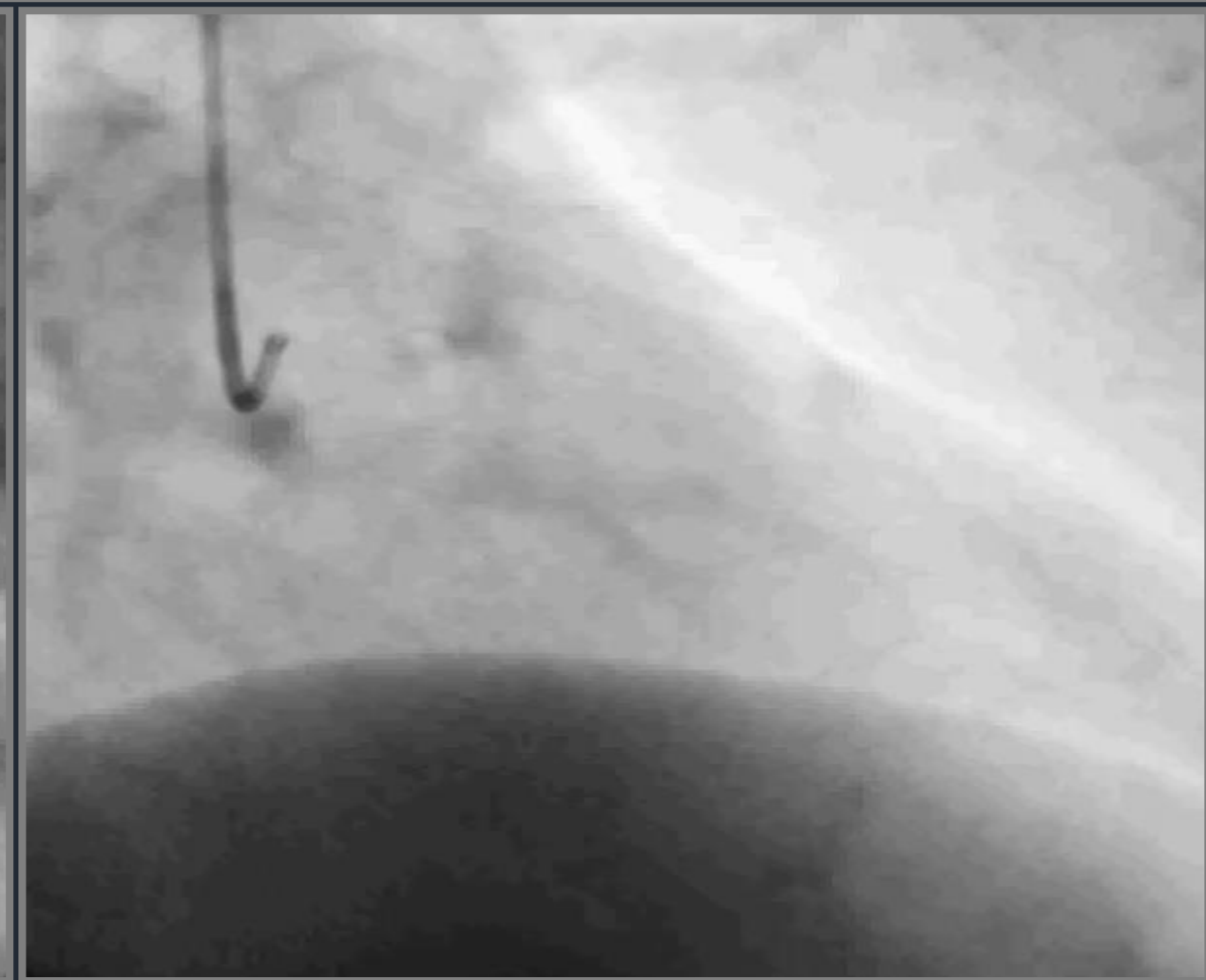
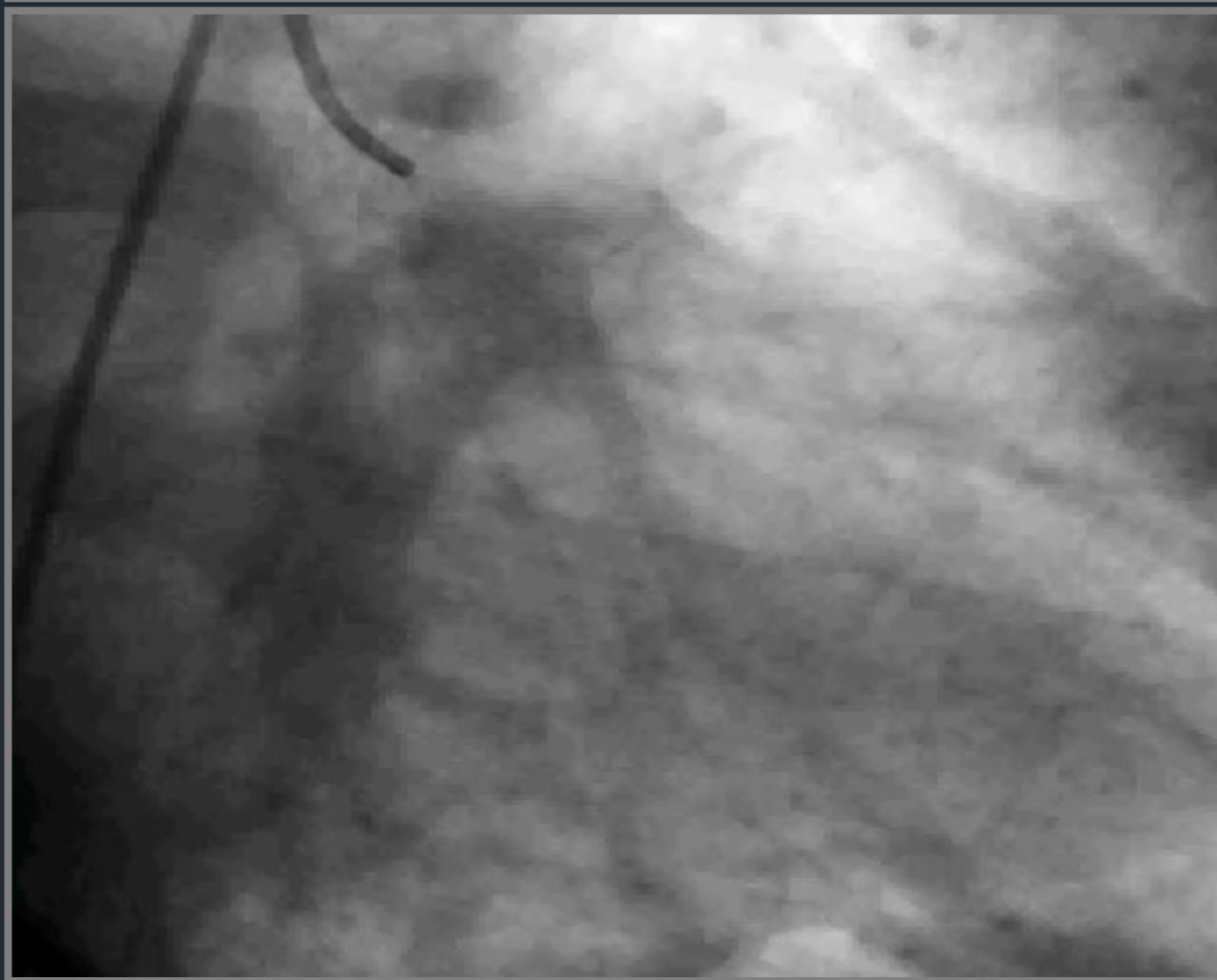
Propensity Matched Population



Jeong DS, Lee YT, Chung SR et al. *European Journal of Cardio-Thoracic Surgery* 44 (2013) 718–724

Case Presentation: LM Bifurcation and Proximal LAD Disease

57 yo male with NSTEMI, no past medical history, strong family history, refused sternotomy



Case Presentation:

LM Bifurcation and Proximal LAD Disease

57 yo male with NSTEMI, no past medical history, strong family history, refused sternotomy

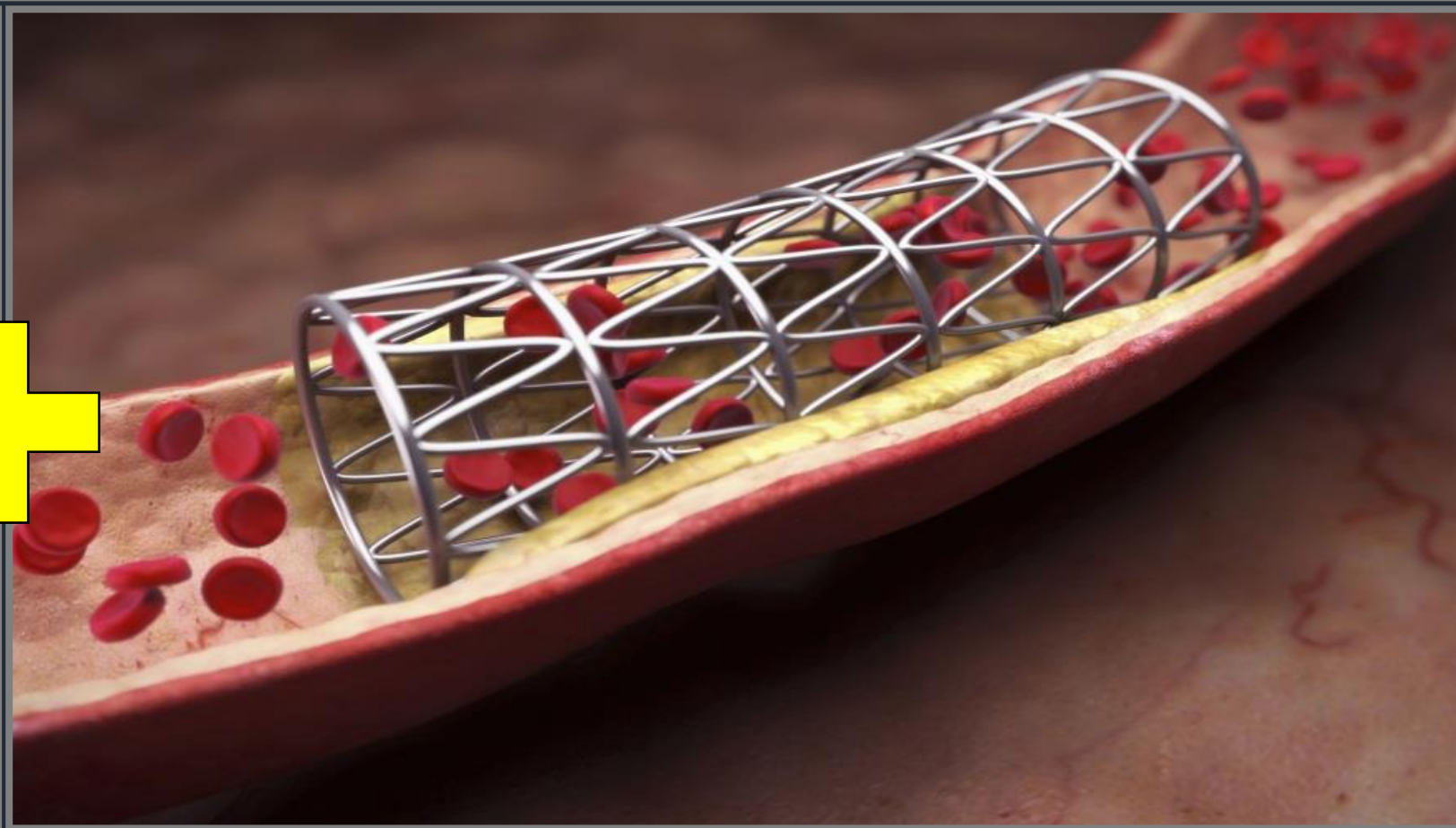
Treatment Strategy:

Robotic assisted LIMA-LAD

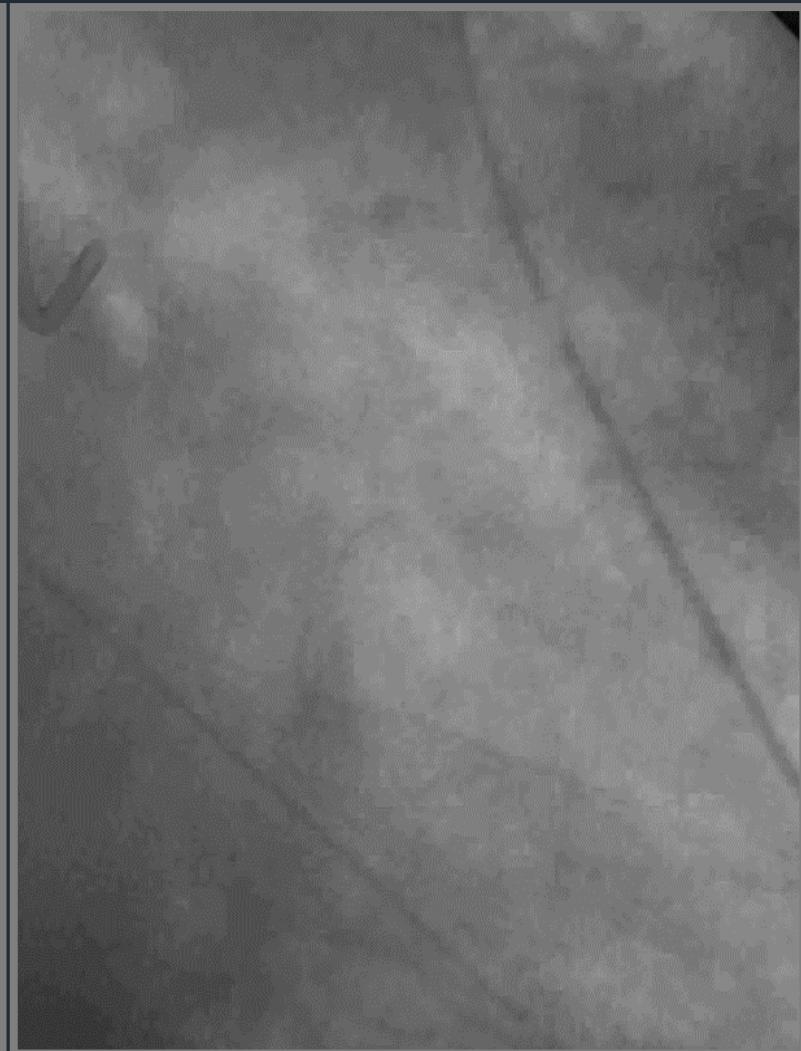
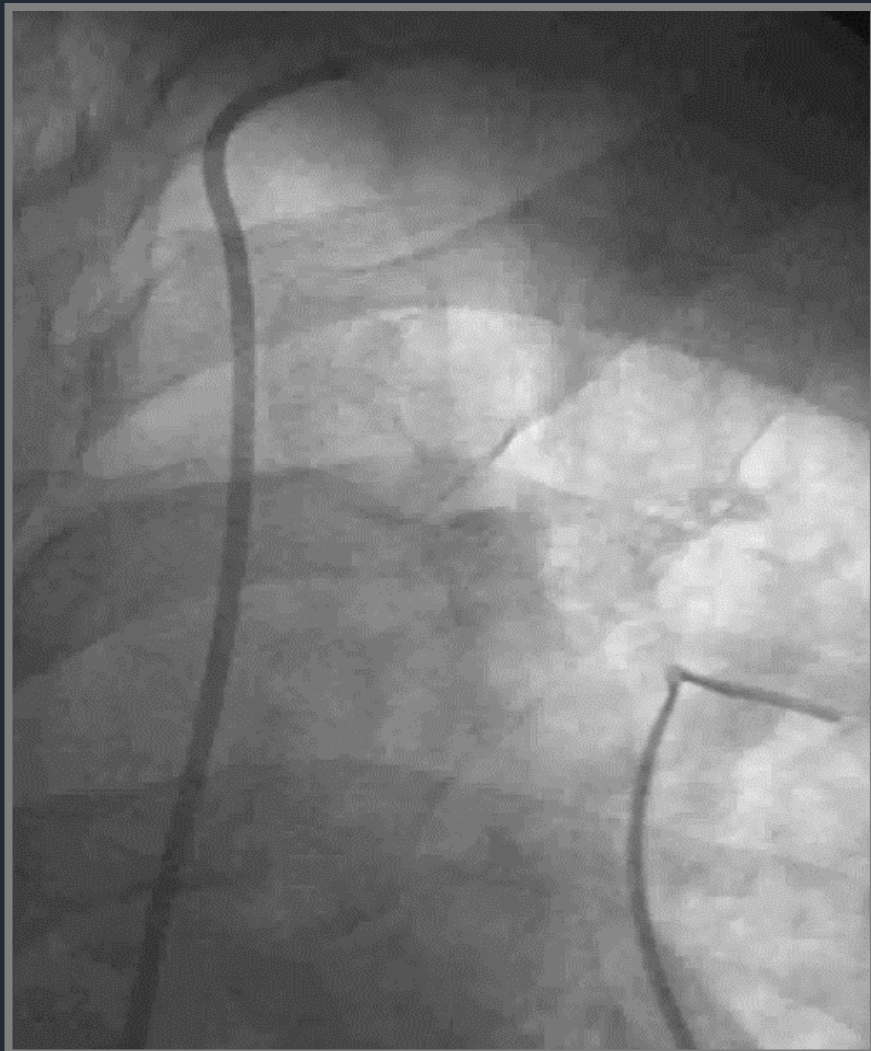
Subsequent PCI of LM into LCx on POD #1

Hybrid Coronary Revascularization

Planned combination of surgical and percutaneous techniques in two different coronary territories, both scheduled and performed within a predefined time period in a patient with multivessel CAD



Treatment Strategy: Robotic assisted LIMA-LAD Subsequent PCI of LM into LCx on POD #1



Treatment Strategy: Robotic assisted LIMA-LAD
Subsequent PCI of LM into LCx on POD #1

Postoperative Course

Taken to cath lab on POD#1

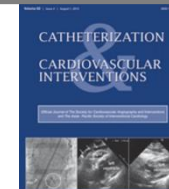
Uncomplicated procedure

Discharged home POD#3

Back to work 2 weeks



Hybrid Coronary Revascularization for the Treatment of Left Main Coronary Stenosis: A Feasibility Study



22 consecutive patients with LM stenosis >70% underwent staged HCR. Following a robotic or thoracoscopic-assisted minimally invasive LIMA to LAD CABG, PCI of the LM, and non-LAD targets was performed after angiographic confirmation of LIMA patency. IVUS confirmed optimal stent deployment. 30 day adverse outcomes and long term follow up was obtained

Procedural Characteristics

Procedural characteristics	N
<i>Surgery related</i>	
LIMA patency pre PCI	22/22 (100%)—Fitzgibbon A
<i>PCI related</i>	
DES	21/22
BMS	1/22 (5 mm BMS for large caliber LM)
IVUS guidance	22/ 22 (100%)

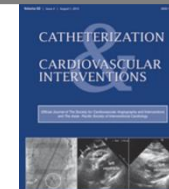
Outcomes

Outcome measures	
Mean ICU stay	1.1 ± 0.4 days (1–3)
Re exploration with transfusion of blood products	2/22
Hybrid surgery/PCI same hospitalization	15/22
Staged interval Hospitalization	3.8 ± 1.4 days (2–6)
MACCE	6.1 ± 2.4 days (3–10)
In hospital	0
30 days	0
Death	1 ^a
Duration of follow up (mean ± SD)	38.8 ± 22.6 months

Rab ST, Douglas JD, Lyons E et al. *Catheter Cardiovasc Interv.* 2012 Aug 1;80(2):238-44



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Conclusion:

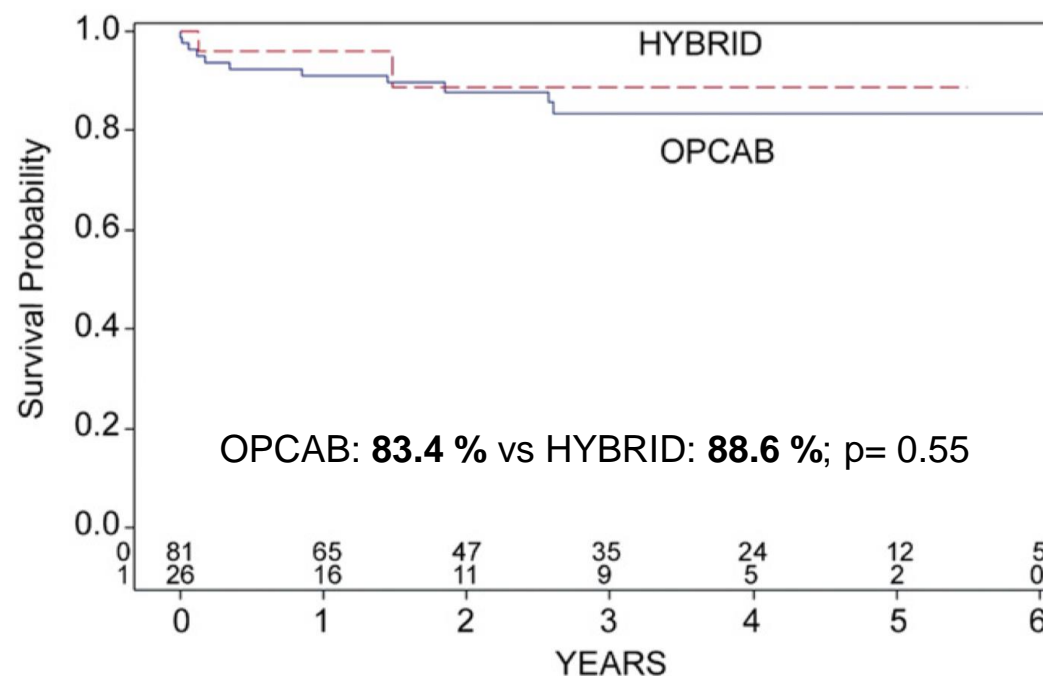
Hybrid revascularization for LM coronary artery stenosis appears to be a safe and feasible procedure in selected patients and may preserve the survival advantage imparted by the left internal mammary artery graft to the LAD.

DES	21/22	Hospitalization	6.1 ± 2.4 days (3–10)
BMS	1/22 (5 mm BMS for large caliber LM)	MACCE	
		In hospital	0
		30 days	0
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Hybrid Coronary Revascularization Versus Off-Pump Coronary Artery Bypass for the Treatment of Left Main Coronary Stenosis

27 patients with LM coronary disease had HCR and were matched 3:1 to 81 contemporaneous patients treated with off-pump CABG through a sternotomy. In-hospital major adverse cardiac and cerebrovascular events and repeat revascularization during the study period were compared between groups.



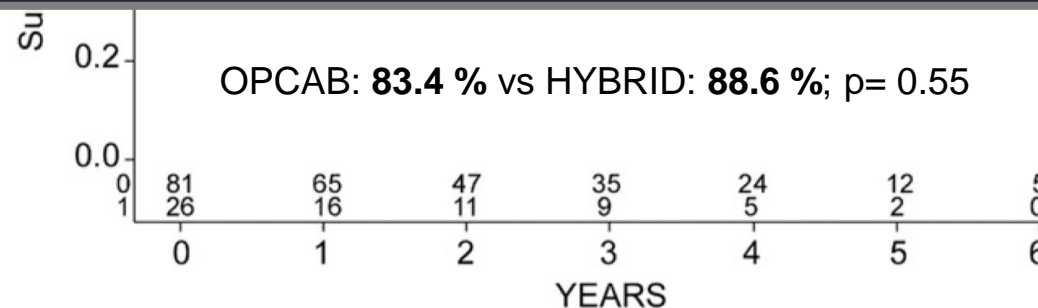
Halkos ME, Rab ST, Vassiliades TA et al. *Ann Thorac Surg.* 2011 Dec;92(6):2155-60

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Conclusion:

Hybrid revascularization is a safe, feasible, and minimally invasive alternative to off-pump coronary artery bypass grafting for the treatment of LM. Further investigation into the comparative effectiveness of this alternative strategy is warranted to identify optimal candidates for HCR.



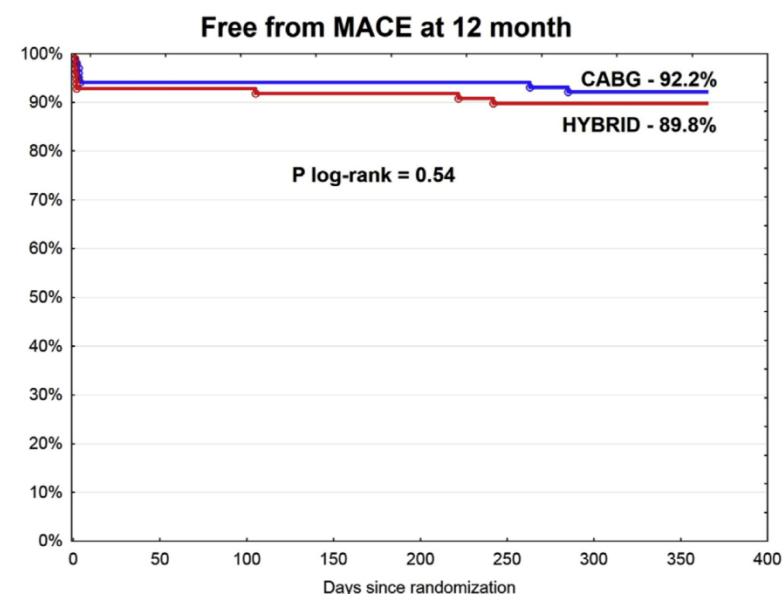
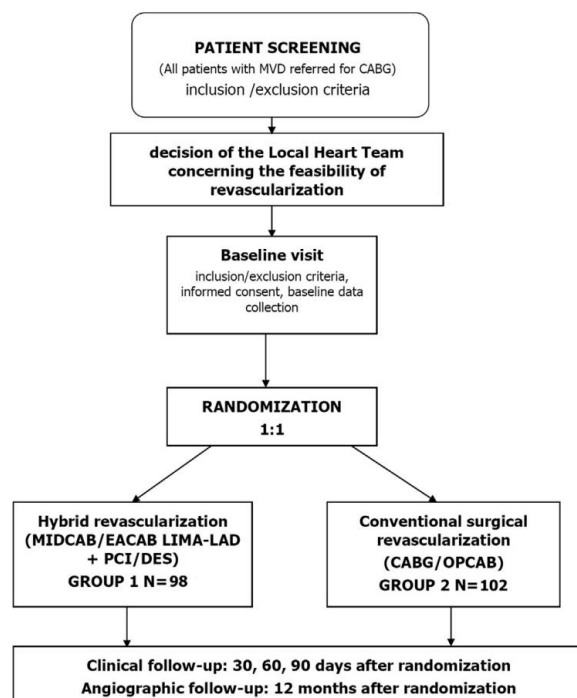
Halkos ME, Rab ST, Vassiliades TA et al. *Ann Thorac Surg.* 2011 Dec;92(6):2155-60



Hybrid Revascularization for Multivessel Coronary Artery Disease

200 patients with MVCAD involving the LAD and a critical (>70%) lesion in at least 1 major epicardial vessel (except the LAD) were randomly assigned to undergo HCR or CABG (in a 1:1 ratio)

The primary endpoint was the evaluation of the safety of HCR. The feasibility was defined by the % of patients with a complete HCR procedure and the % of patients with conversions to standard CABG. The occurrence of MACE such as death, MI, stroke, repeated revasc, and major bleeding within the 12-month period after randomization was also assessed.



Gasior M, Zembala M, Tajstra M et al. J Am Coll Cardiol Intv 2014;7:1277-83



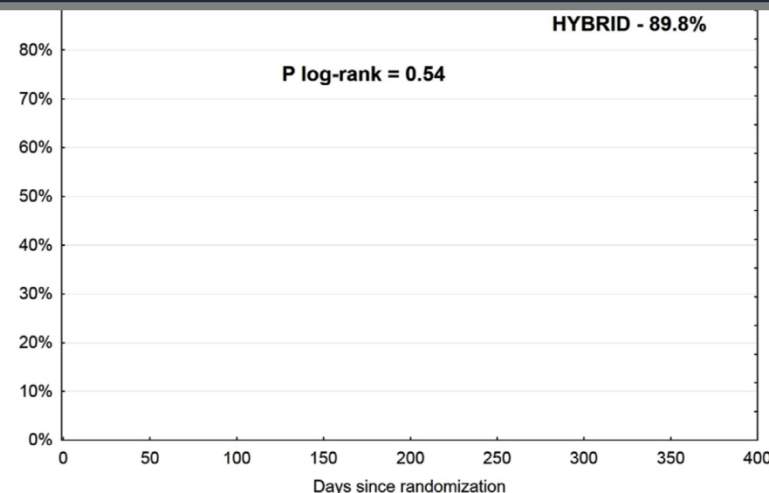
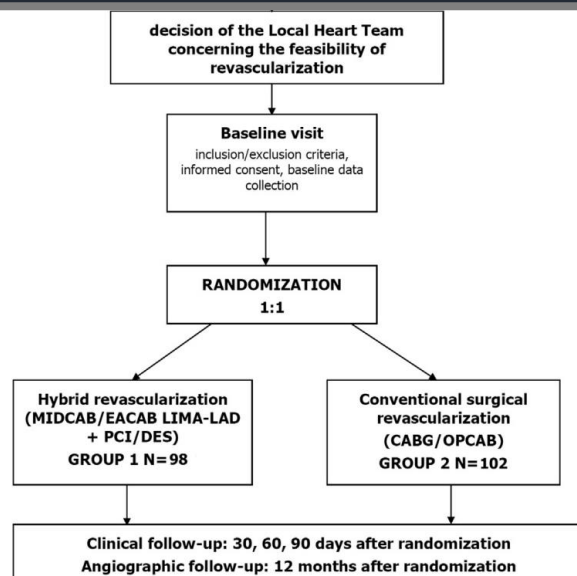
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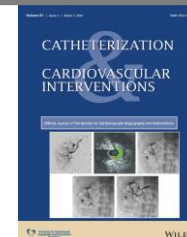
HCR is feasible in selected patients with MVCAD referred for conventional CABG



Gasior M, Zembala M, Tajstra M et al. *J Am Coll Cardiol Intv* 2014;7:1277-83



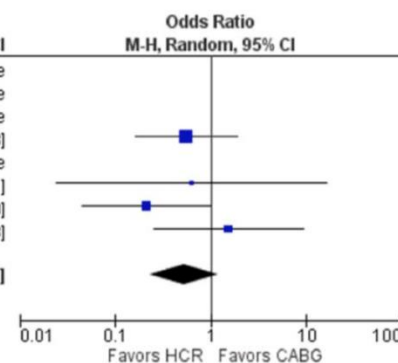
Hybrid Coronary Revascularization Versus Coronary Artery Bypass Grafting in Patients With Multivessel Coronary Artery Disease: A Meta-Analysis



Studies comparing HCR with CABG for treatment of MVCAD were selected. Summary odds ratios (ORs) and 95% CIs with the random-effects model were calculated. The primary outcome of interest was the occurrence of major adverse cardiac and cerebrovascular events (MACCE), defined as a composite of all cause mortality, myocardial infarction, and stroke.

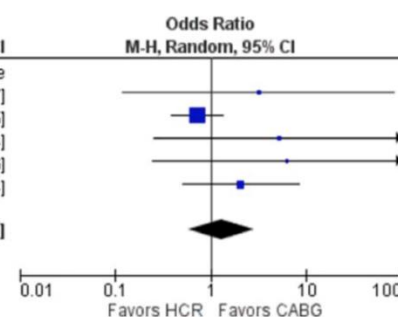
B: Stroke with HCR versus CABG

Study or Subgroup	HCR		CABG		Weight	Odds Ratio M-H, Random, 95% CI
	Events	Total	Events	Total		
Bachinsky 2012	0	25	0	27		Not estimable
de Canniere 2011	0	20	0	20		Not estimable
Delhay 2010	0	18	0	18		Not estimable
Harskamp 2015	3	306	16	918	44.3%	0.56 [0.16, 1.93]
HYBRID 2014	0	98	0	102		Not estimable
Kon 2008	0	15	1	30	6.4%	0.63 [0.02, 16.51]
Shen 2013	2	141	9	141	28.3%	0.21 [0.04, 0.99]
Zhao 2009	2	112	3	254	21.0%	1.52 [0.25, 9.23]
Total (95% CI)		735		1510	100.0%	0.53 [0.23, 1.20]
Total events	7		29			
Heterogeneity: Tau ² = 0.00; Chi ² = 2.71, df = 3 (P = 0.44); I ² = 0%						
Test for overall effect: Z = 1.52 (P = 0.13)						



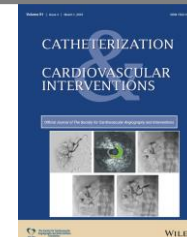
C: Repeat revascularization with HCR versus CABG

Study or Subgroup	HCR		CABG		Weight	Odds Ratio M-H, Random, 95% CI
	Events	Total	Events	Total		
Bachinsky 2012	0	25	0	27		Not estimable
Delhay 2010	1	18	0	18	5.5%	3.17 [0.12, 83.17]
Harskamp 2015	13	306	53	918	59.0%	0.72 [0.39, 1.35]
HYBRID 2014	2	98	0	102	6.3%	5.31 [0.25, 112.04]
Kon 2008	1	15	0	30	5.5%	6.31 [0.24, 164.56]
Shen 2013	6	141	3	141	23.6%	2.04 [0.50, 8.34]
Total (95% CI)		603		1236	100.0%	1.28 [0.58, 2.83]
Total events	23		56			
Heterogeneity: Tau ² = 0.18; Chi ² = 4.90, df = 4 (P = 0.30); I ² = 18%						
Test for overall effect: Z = 0.62 (P = 0.54)						





Hybrid Coronary Revascularization Versus Coronary Artery Bypass Grafting in Patients With Multivessel Coronary Artery Disease: A Meta-Analysis



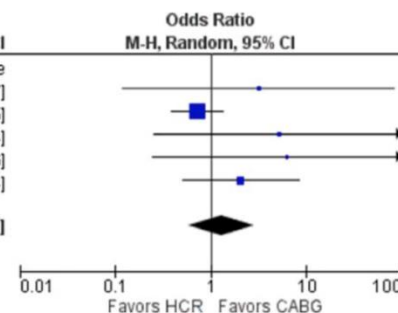
Studies comparing HCR with CABG for treatment of MVCAD were selected. Summary odds ratios (ORs) and 95% CIs with the random-effects model were calculated. The primary outcome of interest was the occurrence of major adverse cardiac

Conclusion:

HCR appears to be safe, and has similar outcomes when compared with conventional CABG. HCR can be a suitable alternative to conventional CABG in select patients with MVCAD

C: Repeat revascularization with HCR versus CABG

Study or Subgroup	HCR		CABG		Weight	Odds Ratio M-H, Random, 95% CI
	Events	Total	Events	Total		
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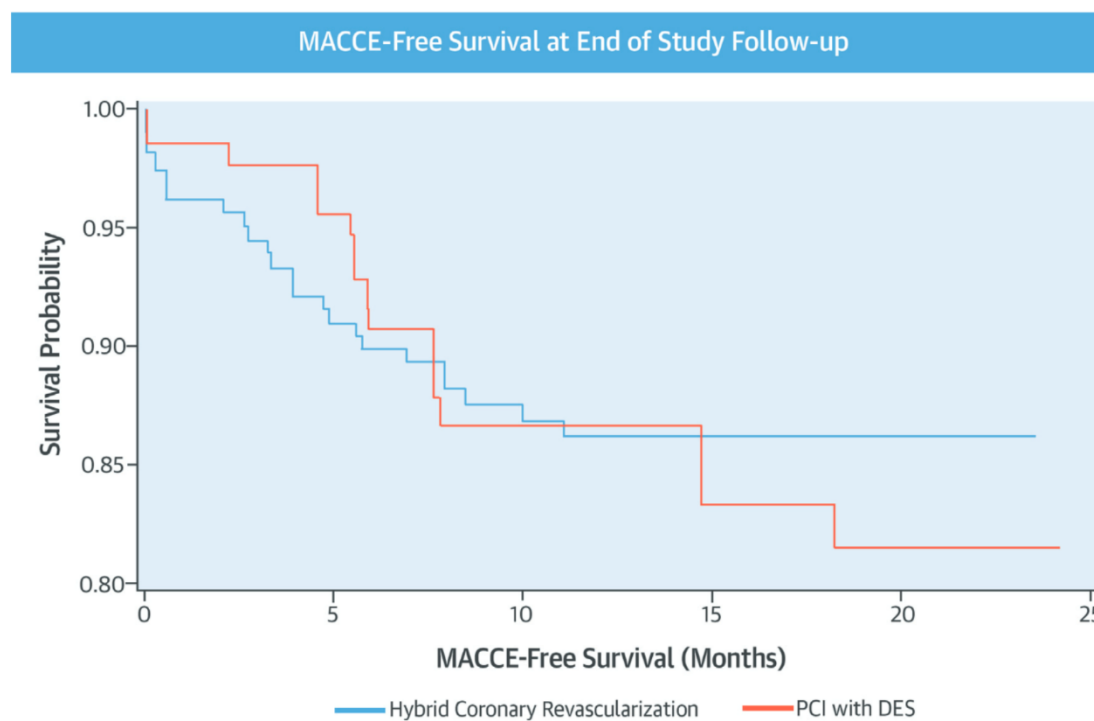
Sardar P, Kandu A, Bischoff M et al. *Catheter Cardiovasc Interv.* 2018 Feb 1;91(2):203-212

Hybrid Coronary Revascularization for the Treatment of Multivessel Coronary Artery Disease

A Multicenter Observational Study



200 HCR and 98 multivessel PCI patients were enrolled at 11 sites. The primary outcome was major adverse cardiac and cerebrovascular events (MACCE) (death, stroke, MI, repeat revasc) within 12 months post-intervention. Cox proportional hazards models were used to model time to First MACCE event



Puskas J, Halkos M, DeRose J et al. J Am Coll Cardiol 2016;68:356–65

Therefore:

HCR is a safe and feasible procedure and utilizes the
“ **BEST OF BOTH WORLDS STRATEGY** ”

HCR is **non inferior to OPCAB** with low TVR rates
while OPCAB (with a sternotomy) is superior to PCI

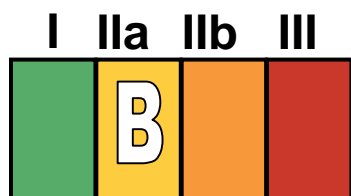
Numbers are small in observational studies and small trials

Requires **dedicated cardiac surgeon**, facile with the **Da Vinci Robot** or endoscopic technique
Increased procedural **costs are offset** by decreased length of stay, ICU care, need for blood
products and convalescence

Compared to OPCAB, **HCR increases hospital contribution margins**

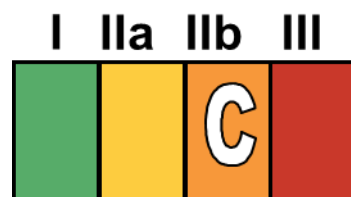
Puskas J, Halkos M, DeRose J et al. J Am Coll Cardiol 2016;68:356–65

Hybrid Coronary Revascularization



Hybrid coronary revascularization (defined as the planned combination of left internal mammary artery-to-LAD artery grafting and PCI of ≥ 1 non-LAD coronary arteries) is reasonable in patients with 1 or more of the following:

- a. Limitations to traditional CABG, such as a heavily calcified proximal aorta or poor target vessels for CABG (but amenable to PCI);
- b. Lack of suitable graft conduits;
- c. Unfavorable LAD artery for PCI (i.e., excessive vessel tortuosity or chronic total occlusion).



Hybrid coronary revascularization (defined as the planned combination of LIMA-to-LAD artery grafting and PCI of ≥ 1 non-LAD coronary arteries) may be reasonable as an alternative to multivessel PCI or CABG in an attempt to improve the overall risk-benefit ratio of the procedures.



*Helping Cardiovascular Professionals
Learn. Advance. Heal.*

2011 ACCF/AHA Guidelines for
Coronary Artery Bypass Graft Surgery



Hybrid Coronary Revascularization As An Alternative to Multivessel PCI: The Hybrid Trial

John D. Puskas, MD, MSc, FACS, FACC

Professor and Chairman

Department of Cardiovascular Surgery, Mount Sinai Saint Luke's
Director, Surgical Coronary Revascularization, Mount Sinai Health System

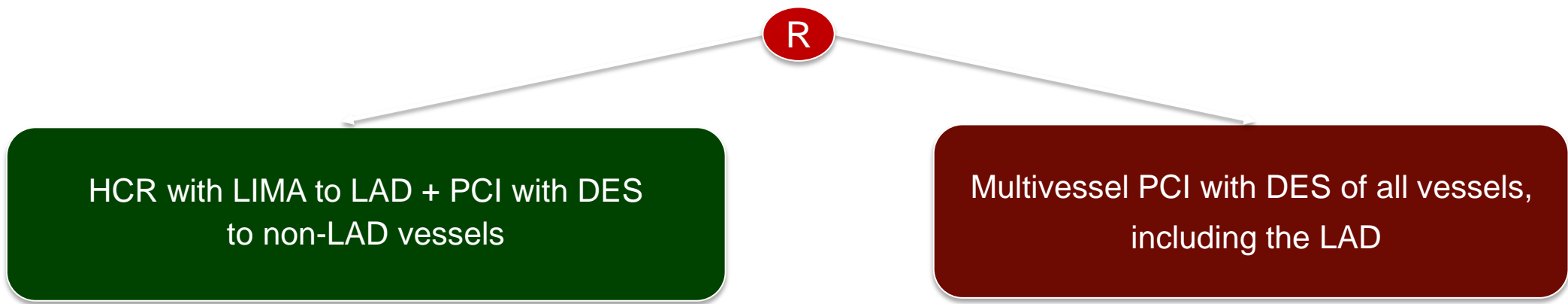
EACTS 2018

Milano, Italy

October 19, 2018

Randomized Trial of HCR vs. PCI

2,354 pts at up to 70 sites with MVD involving the LAD distribution eligible for both HCR and PCI with DES



Follow-up: 30 days, 6 months, and then every 6 months through 5 years

Primary endpoint

5-year MACCE (death, MI, stroke, or repeat revascularization)

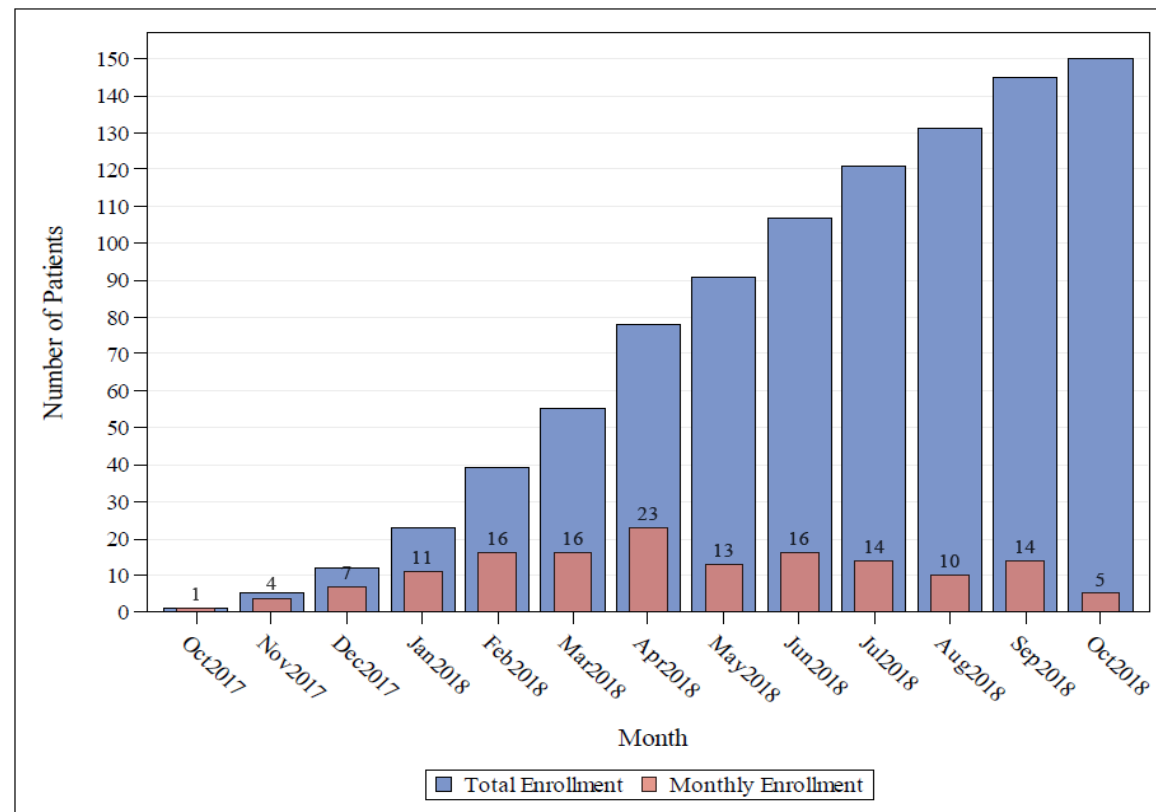
Powered to detect superiority of HCR over PCI

Principal Investigators: John D. Puskas and Gregg W. Stone
Clinical and Data Coordinating Center: InCHOIR, Mt Sinai, NY, NY

Sponsored by NHLBI

Randomized Trial of HCR vs. PCI

2,354 pts at up to 70 sites with MVD involving the LAD distribution eligible for both HCR and PCI with DES



150 Randomized

325 Eligible

1622 Screened

TARGET 2354



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TCT Asia Pacific 2019, Seoul, South Korea
April 29th | 11:58-12:06 pm

24th CARDIOVASCULAR SUMMIT
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April 27-30, 2019, Coex, Seoul, Korea

Conclusions

For certain patients with LM disease the long term might favor **hybrid revascularization** with **LIMA to the LAD** and **DES to the Left Main and Circumflex**

Unfortunately the **trial to answer that question has been stopped** but perhaps someone will take it up again

Meanwhile **hybrid revascularization** will remain an **attractive option** for some centers willing to commit to it