Coronary Artery Bypass Grafting in multivessel disease - 2010

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Presentation outline

- PCI vs. CABG for LMS and 3-VD
- guide for better surgery
- unmet promises of minimally invasive surgery
- personal perspective

CABG vs. medical therapy

- survival benefit for CABG in patients with:
  - 2- or 3-vessel coronary artery disease involving the proximal LAD
  - significant left main stem stenosis

- the benefits were magnified in:
  - pts with severe symptoms
  - pts with impaired LV function

Trials of PCI vs. CABG

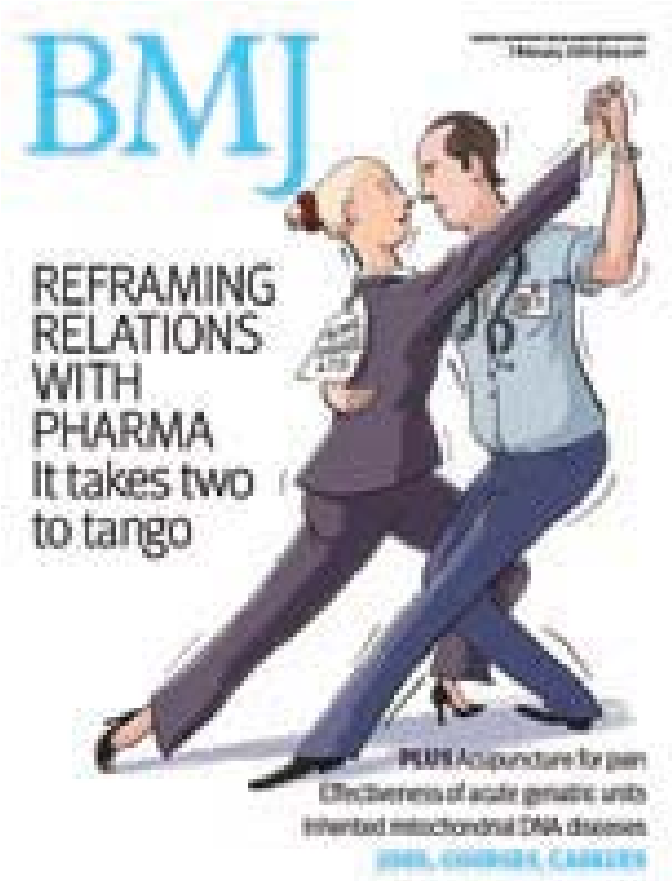
- CABG reduces the need for reintervention 3- to 4-fold
- Lack of significant survival benefit due to:
  - severe limitations of trials
  - 1- or 2-vessel disease
  - inclusion of only 1% to 10% of eligible population
  - mainly normal LV function

Trials of PCI vs. CABG

- CABG reduces the need for reintervention 3- to 4-fold
- La
  - severe
  - 1- or
  - mainly normal LV fu

the trials were biased against the prognostic benefit of CABG

It takes two to tango ….



Registry Data

9 large registries of propensity-matched patients:

1. Brener SJ, Lytle BW, Casserly IP, et al. Propensity analysis of long-term survival after surgical or percutaneous revascularization in patients with multivessel coronary artery disease and high-risk features. ***Circulation.*** 2004;109:2290–2295.
2. Hannan EL, Racz MJ. Walford get al Long-term outcomes of coronary-artery bypass grafting versus stent implantation. ***N Engl J Med***. 2005;352:2174–2183.
3. Malenka DJ, Leavitt BJ, Hearne MJ, et al.Northern New England Cardiovascular Disease Study Group Comparing long-term survival of patients with multivessel coronary disease after CABG or PCI: Analysis of Bari-like patients in northern New England. ***Circulation.*** 2005;112(suppl):I371–I376.
4. Smith PK, Califf RM, Tuttle RH, et al. Selection of surgical or percutaneous coronary intervention provides differential longevity benefit. ***Ann Thorac Surg***. 2006;82:1420–1428
5. Bair TL, Muhlestein JB, May HT, et al. Surgical revascularization is associated with improved long-term outcomes compared with percutaneous stenting in most subgroups of patients with multivessel coronary artery disease: Results from the intermountain Heart Registry. ***Circulation***. 2007;116(suppl):I226–I231.
6. Hannan EL, Wu C, Walford G, et al. Drug-eluting stents vs. coronary-artery bypass grafting in multivessel coronary disease. ***N Engl J Med***. 2008;358:331–341
7. Niles NW, McGrath PD, Malenka D, et al.Northern New England Cardiovascular Disease Study Group Survival of patients with diabetes and multivessel coronary artery disease after surgical or percutaneous coronary revascularization: Results of a large regional prospective study (Northern New England Cardiovascular Disease Study Group). ***J Am Coll Cardiol***. 2001;37:1008–1015
8. Pell JP, Pell AC, Jeffrey RR, et al. Comparison of survival following coronary artery bypass grafting vs. percutaneous coronary intervention in diabetic and non-diabetic patients: Retrospective cohort study of 6320 procedures. ***Diabet Med***. 2004;21:790–792.
9. BARI Investigators. The final 10-year follow-up results from the Bari randomized trial***. J Am Coll Cardiol***. 2007;49:1600–1606.

Results of Registry Data:

- consistently report that an initial strategy of CABG rather than PCI leads to a significant survival benefit*

- up to 7-fold reduction in the need for reintervention*

**within a few years of the intervention*

SYNTAX trial

(Synergy between PCI with Taxus and Cardiac Surgery)

- a landmark trial because:
  - “all comer” trial
  - parallel registry of patients deemed ineligible for randomization
- will influence how we revascularize pts with LMS and 3-VD

SYNTAX Eligible Patients

SYNTAX

De novo disease

Limited Exclusion Criteria

- Previous interventions
- Acute MI with CPK>2x
- Concomitant cardiac surgery

Left Main Disease
(isolated, +1, +2 or +3 vessels)

3 Vessel Disease
(revasc all 3 vascular territories)

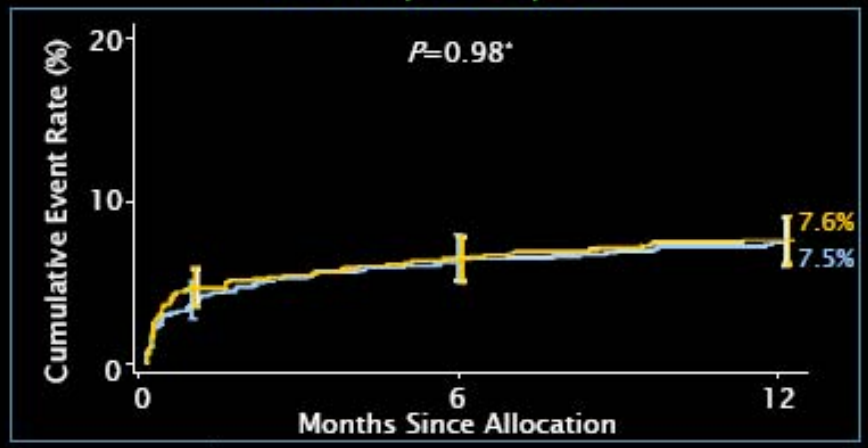
SYNTAX results

- At its 1-year interim analyses of (with final analyses at 5 years) 12% of CABG and 18% of PCI, patients reached the primary composite endpoint of death, myocardial infarction, stroke, or repeat revascularisation
- *"CABG remains the standard of care for patients with 3-vessel or left main coronary artery disease."*

Summary of 1-Year Results

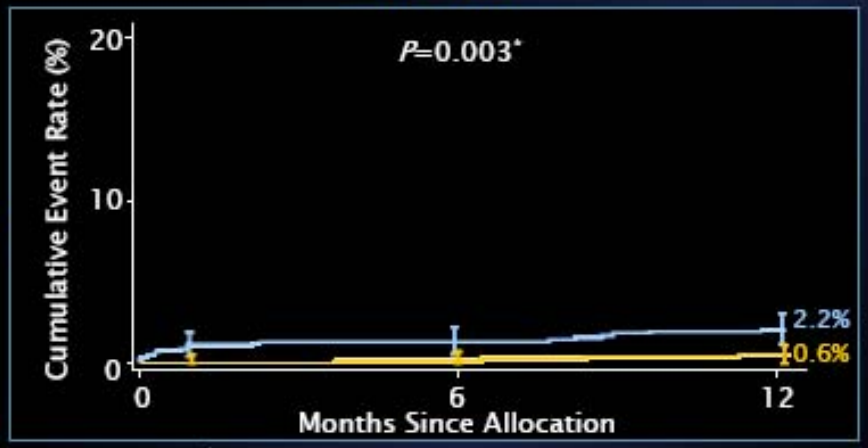
SYNTAX

Death/CVA/MI



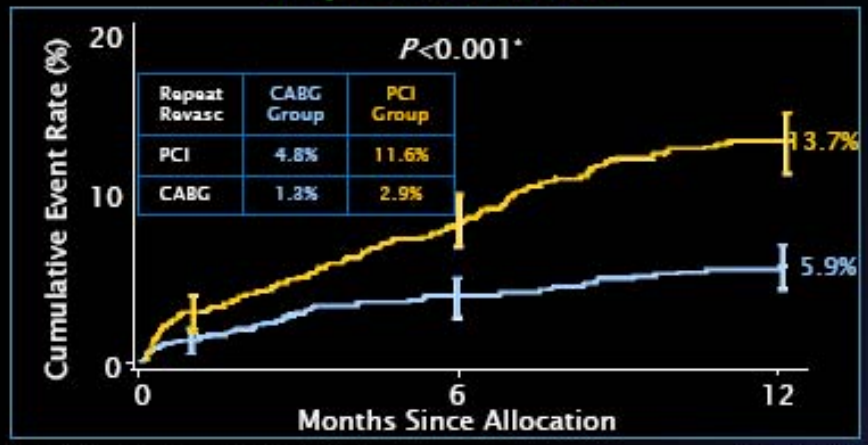
KM Event Rate ± 1.5 SE. *Fisher's Exact Test ITT population

Stroke



KM Event Rate ± 1.5 SE. *Fisher exact test ITT population

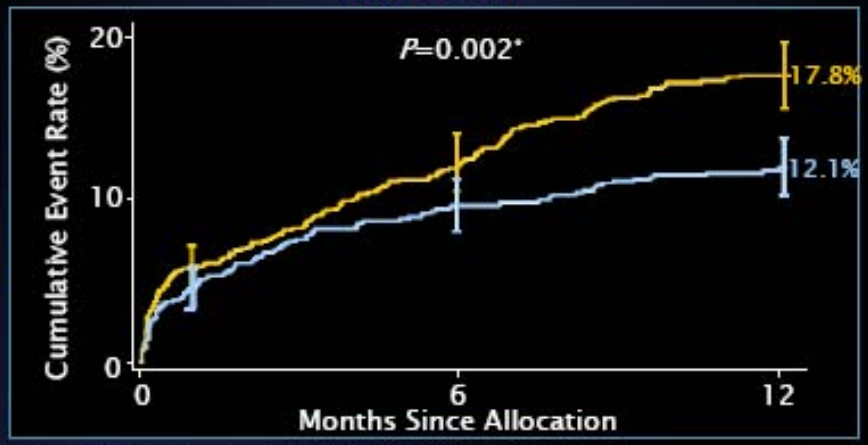
Repeat Revasc.



Repeat Revasc	CABG Group	PCI Group
PCI	4.8%	11.6%
CABG	1.3%	2.9%

KM Event Rate ± 1.5 SE. *Fisher's Exact Test ITT population

MACCE



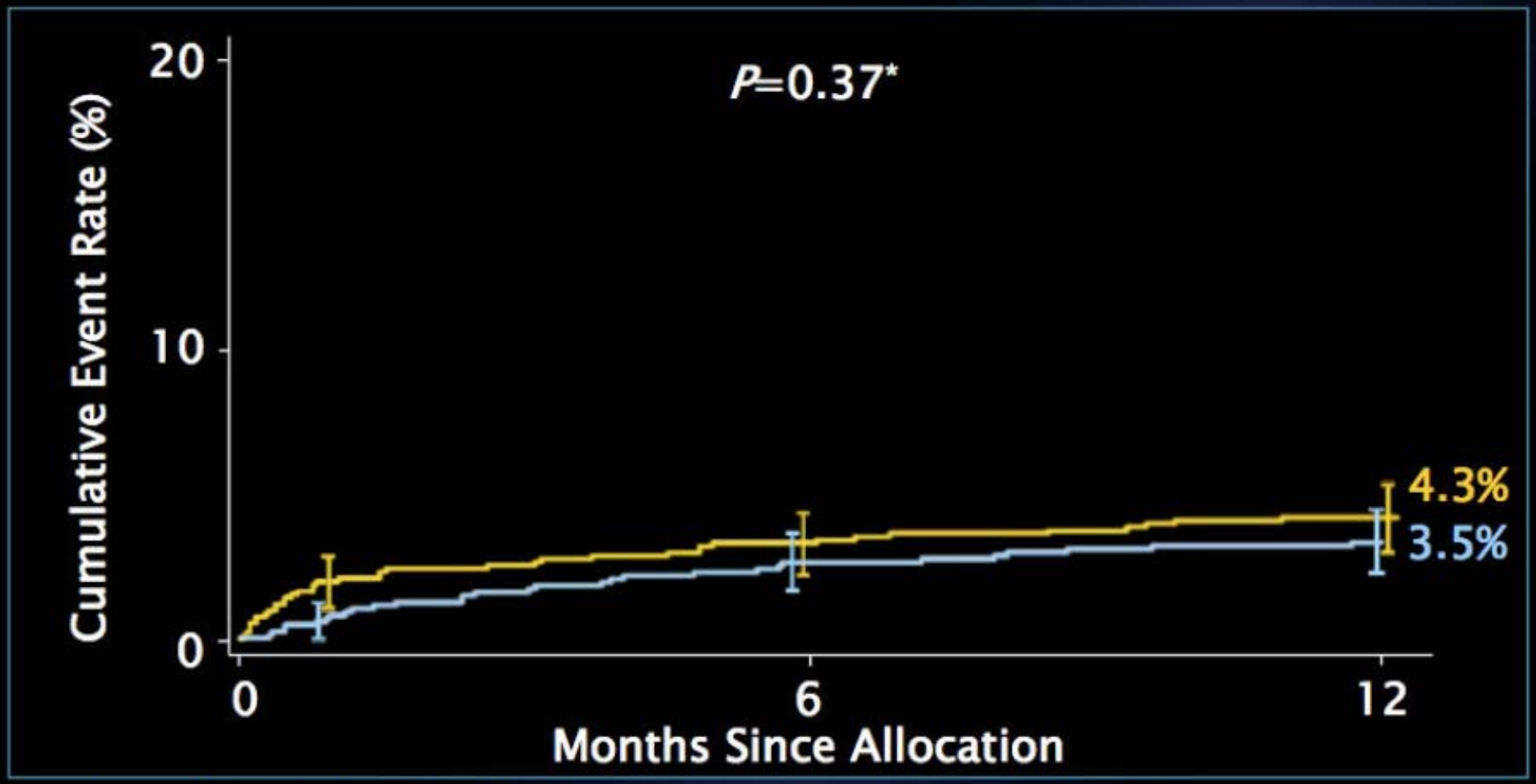
KM Event Rate ± 1.5 SE. *Fisher exact test ITT population

→ Non-inferiority was not met for 12-month MACCE

CABG (N=897) PCI (N=903)

All-Cause Death to 12 Months

SYNTAX

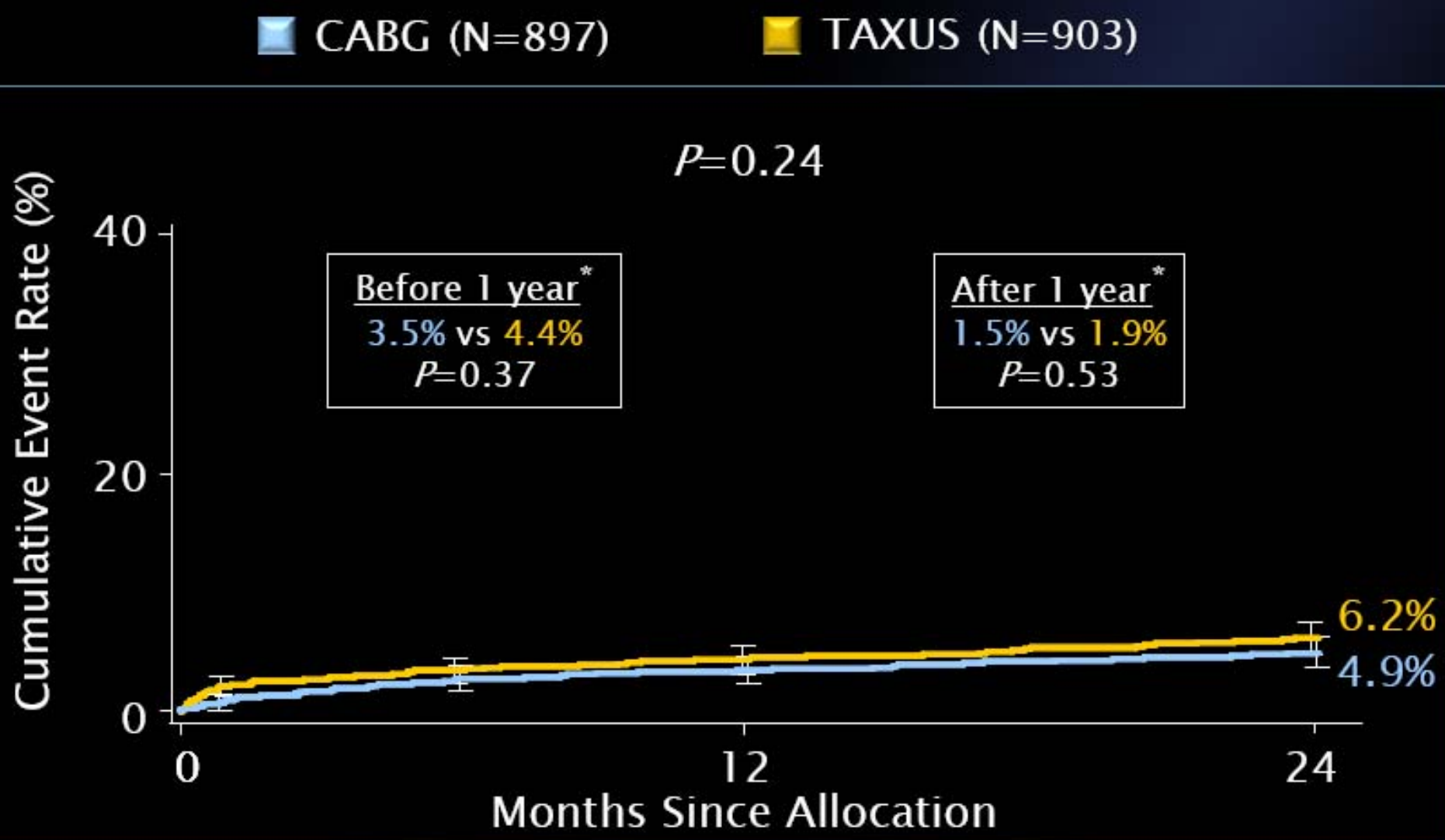


Event Rate ± 1.5 SE. *Fisher's Exact Test

ITT population

All-Cause Death to 2 Years

SYNTAX

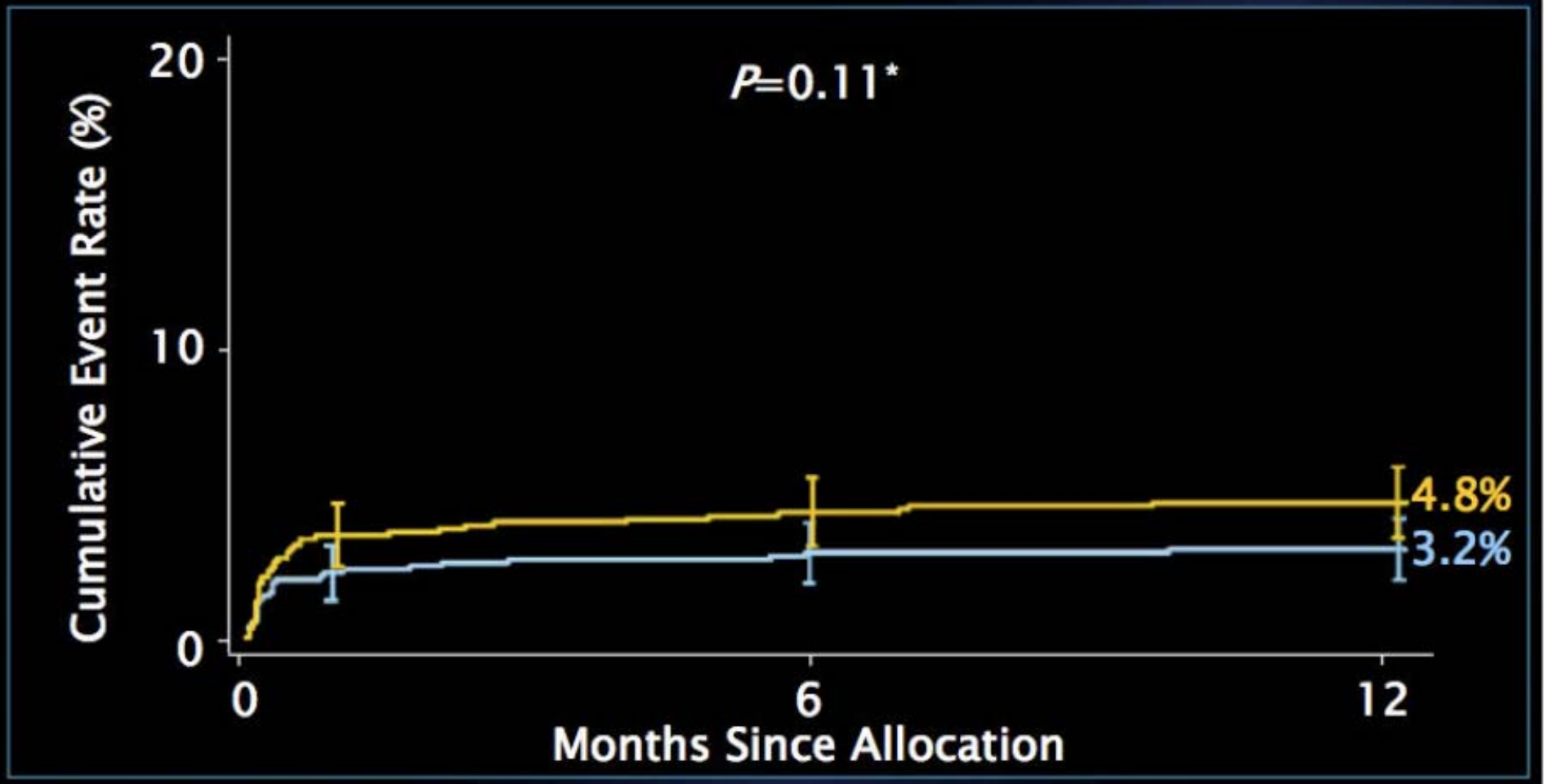


Cumulative KM Event Rate ± 1.5 SE; log-rank *P* value; *Binary rates

ITT population

Myocardial Infarction to 12 Months

SYNTAX

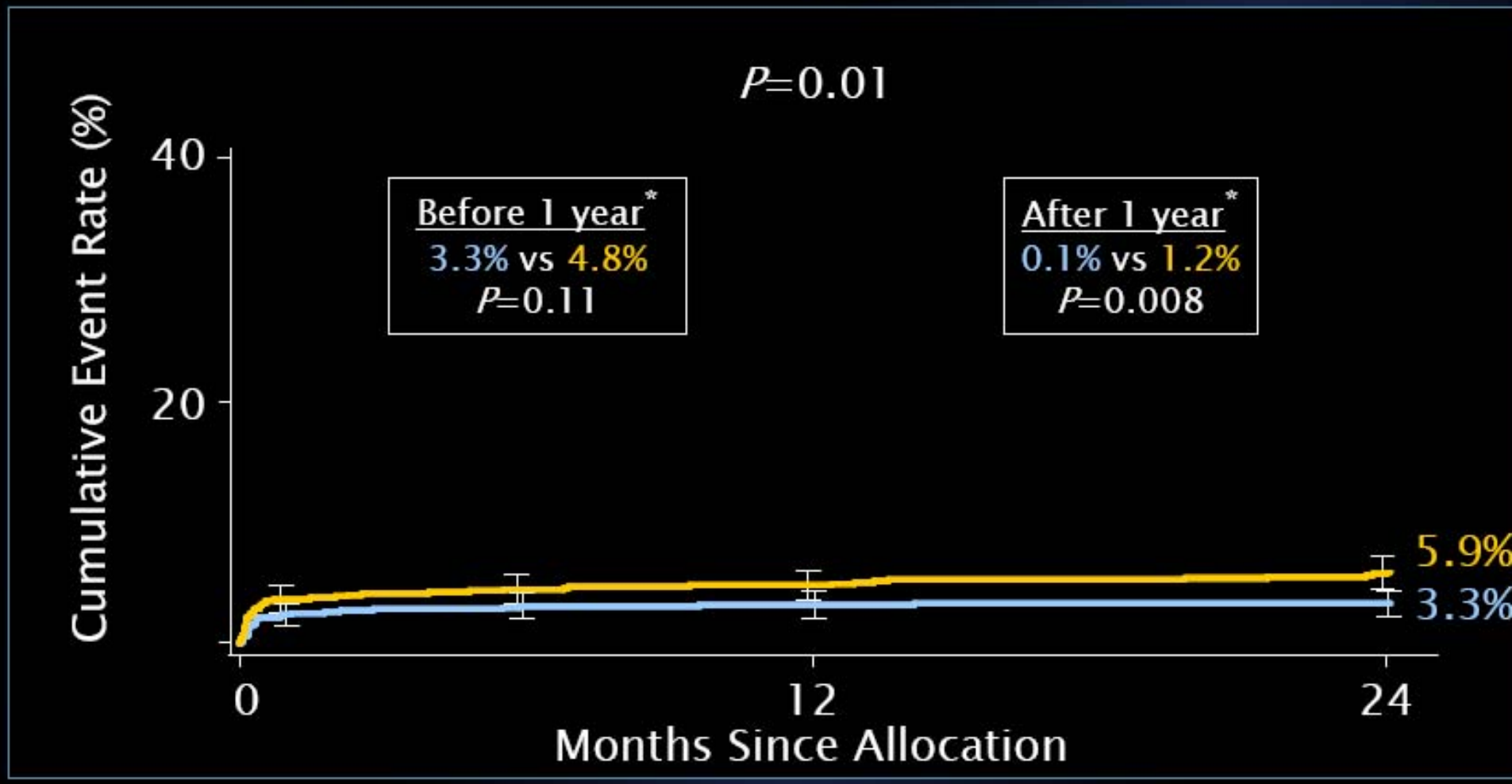


Event Rate ± 1.5 SE. *Fisher's Exact Test

ITT population

Myocardial Infarction to 2 Years

SYNTAX

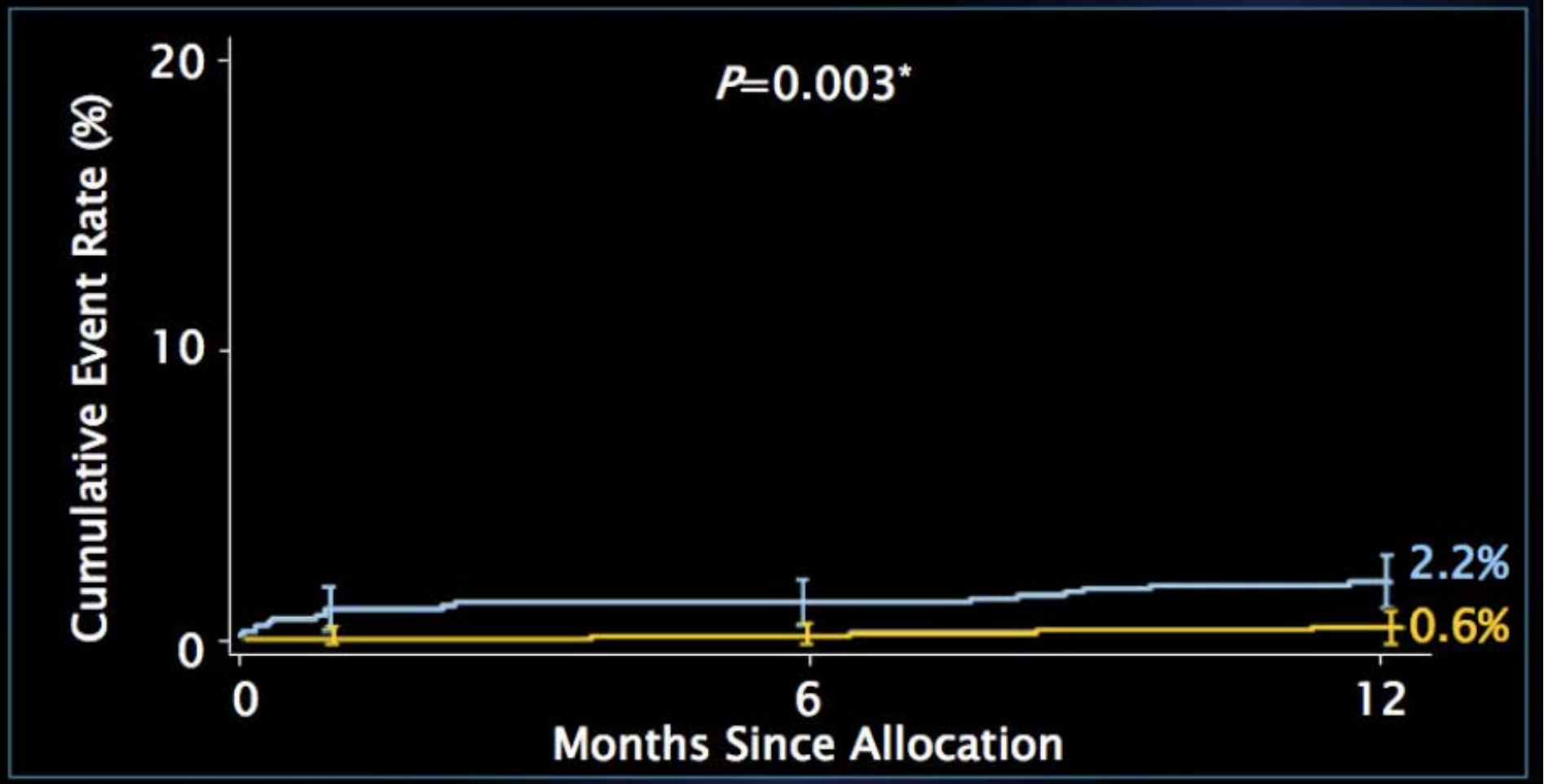


Cumulative KM Event Rate ± 1.5 SE; log-rank *P* value;*Binary rates

ITT populatio

CVA to 12 Months

SYNTAX

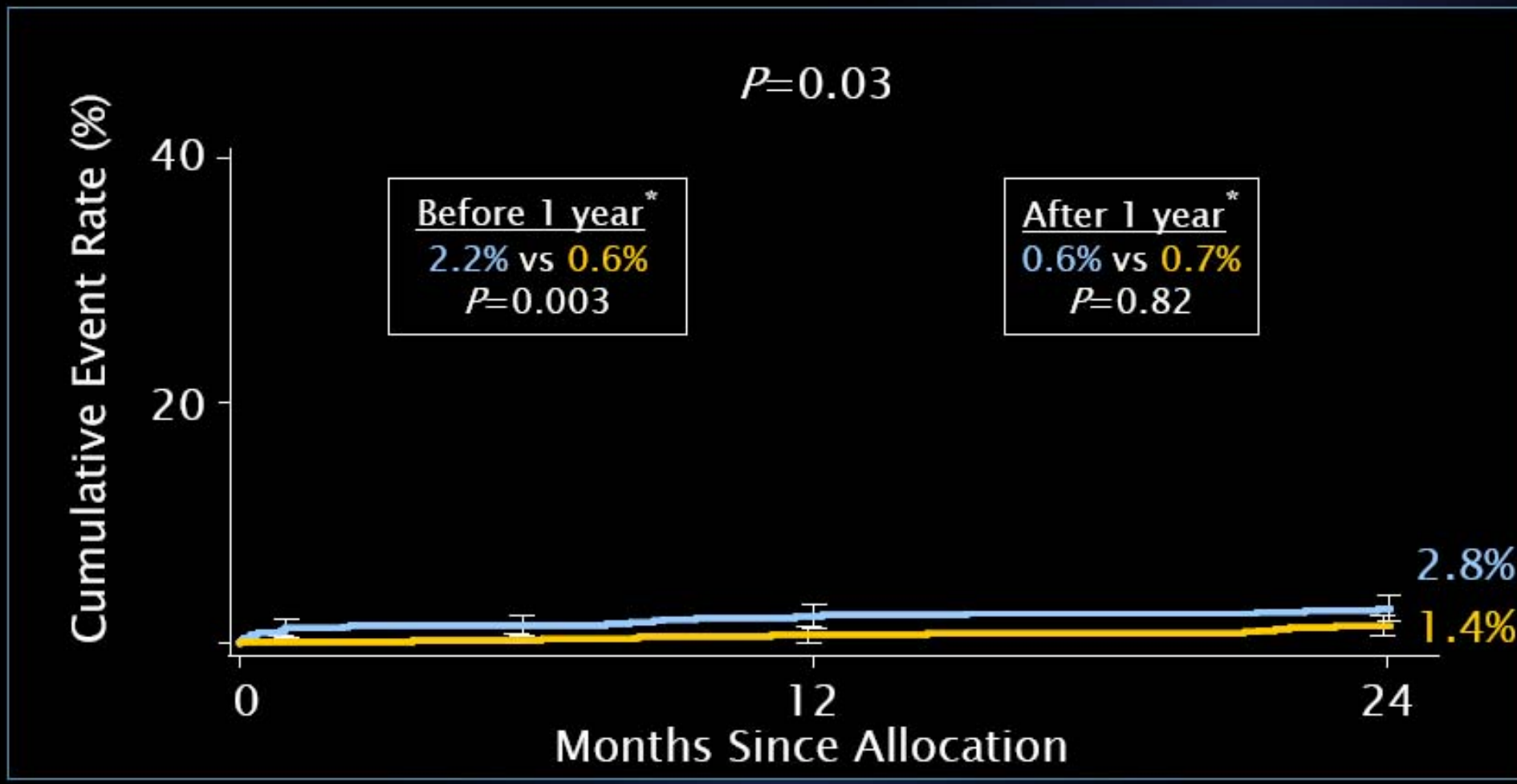


Event Rate ± 1.5 SE. *Fisher's Exact Test

ITT population

CVA to 2 Years

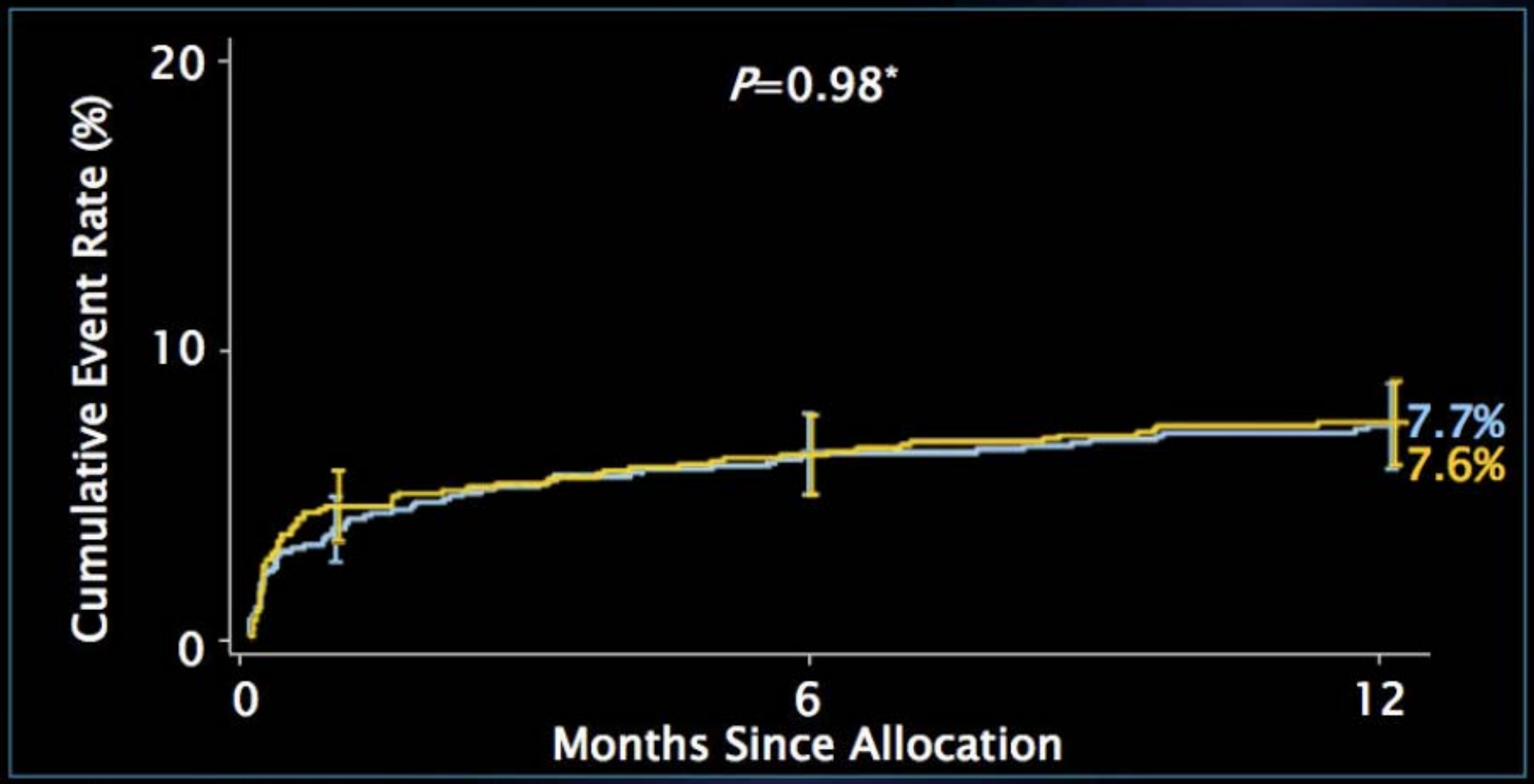
SYNTAX



Cumulative KM Event Rate ± 1.5 SE; log-rank *P* value;*Binary rates

ITT populatio

All-Cause Death/CVA/MI to 12 Months

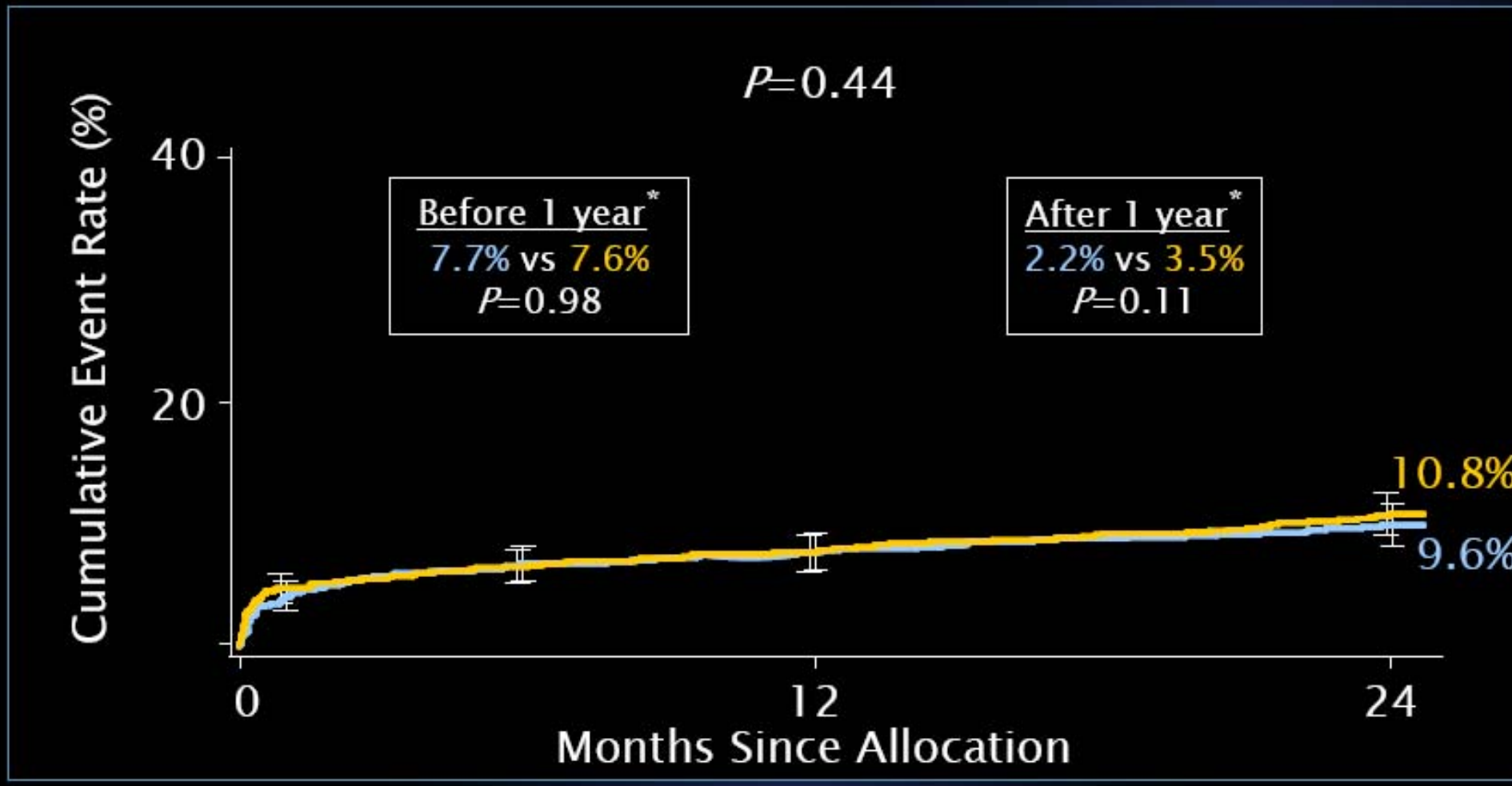


Event Rate ± 1.5 SE. *Fisher's Exact Test

ITT population

All-Cause Death/CVA/MI to 2 Years

SYNTAX

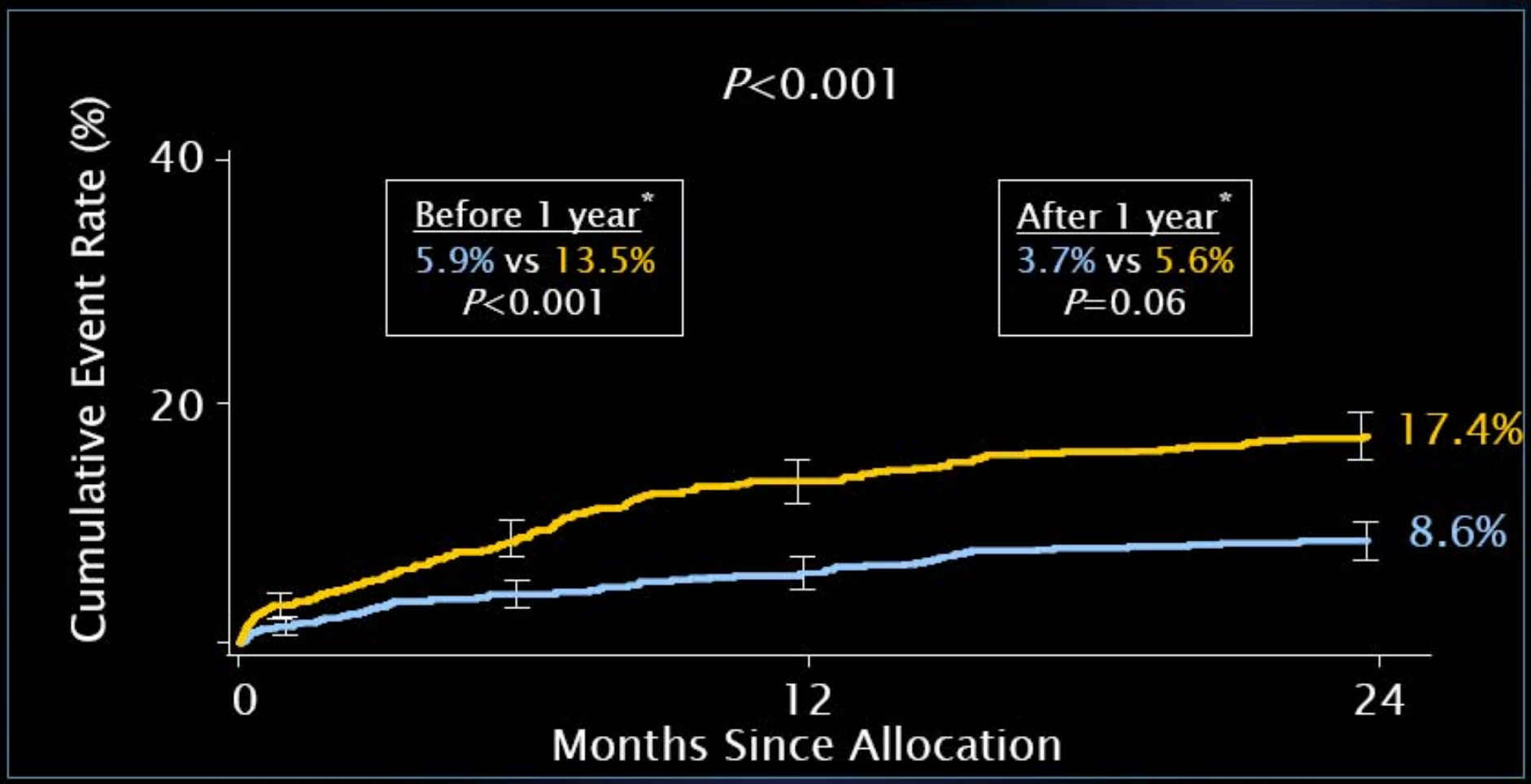


Cumulative KM Event Rate ± 1.5 SE; log-rank *P* value;*Binary rates

ITT populatio

Repeat Revascularization to 2 Years

SYNTAX

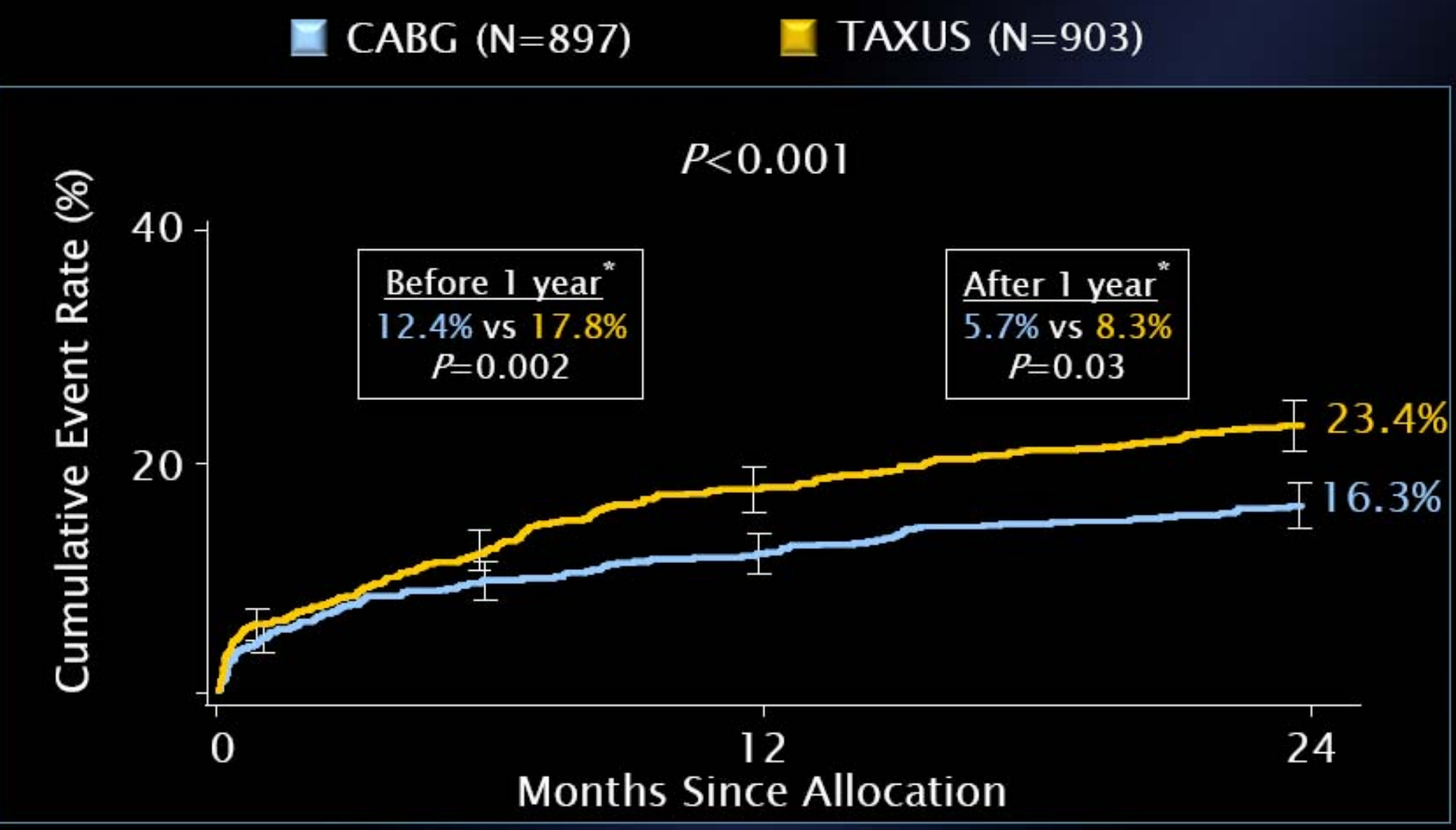


Cumulative KM Event Rate ± 1.5 SE; log-rank *P* value;*Binary rates

ITT population

MACCE to 2 Years

SYNTAX



Cumulative KM Event Rate ± 1.5 SE; log-rank *P* value;*Binary rates

ITT population

Patient Profiling

SYNTAX

Local Heart team (surgeon & interventional cardiologist) assessed each patient with regards to:

- Patient's operative risk (euroSCC
- Coronary (Newly d Score)
- Goal: SY guidance on optimal revascularization strategies for patients with high risk lesions

www.syntaxscore.com

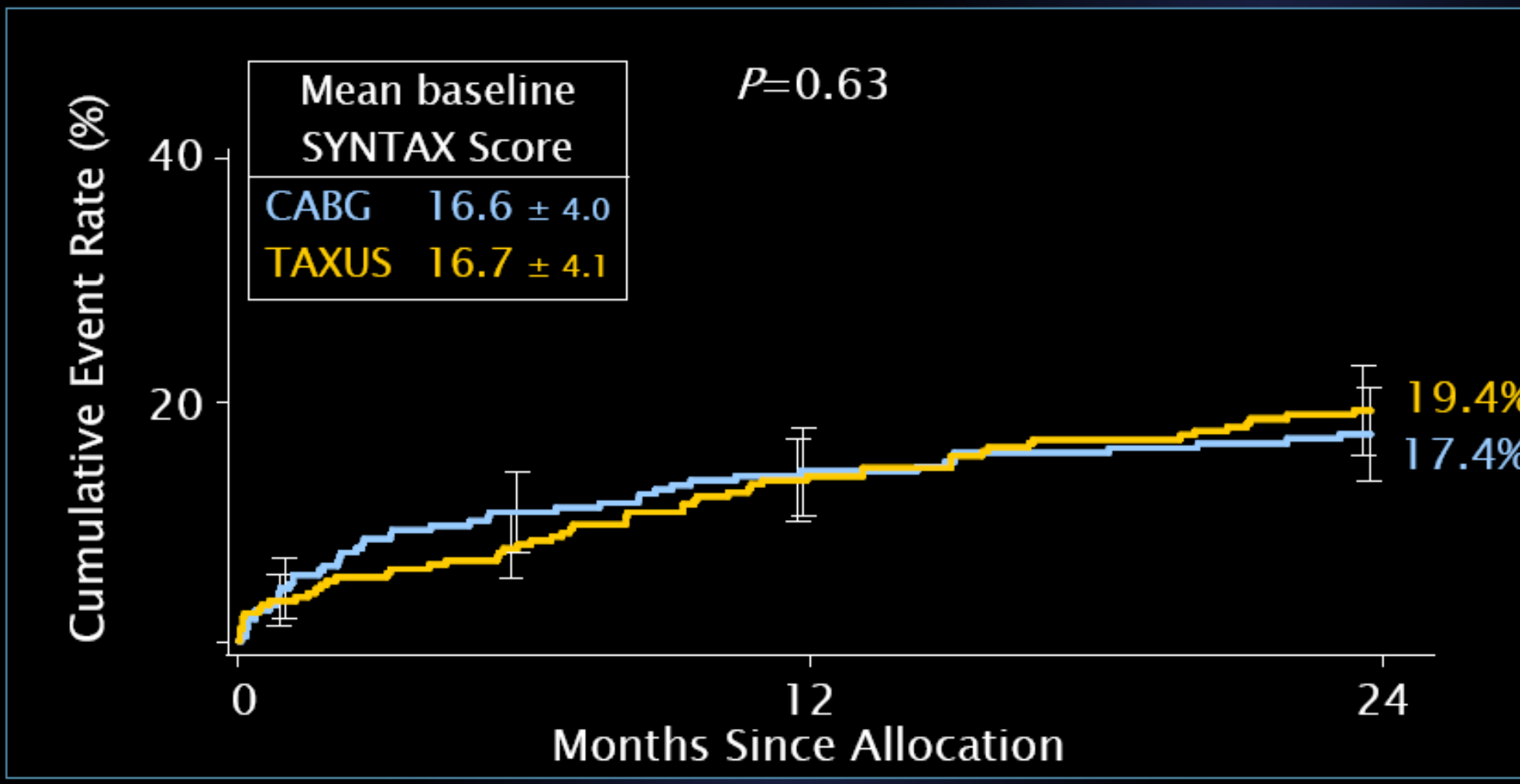
available now

Sianos et al, EuroIntervention 2005;1:219–27
Valgimigli et al, Am J Cardiol 2007;99:1072–81
Serruys et al, EuroIntervention 2007;3:450–9

Coronary tree segments AHA classification and modified for the ARTS study, Circulation 1975; 51:5–40 & Semin Interv Cardiol 1999; 4:209–19
Modified Leaman score, Circ 1981;63:285–92
Lesions classification ACC/AHA , Circ 2001;103:3019–41
Bifurcation classification, CCI 2000;49:274–83
CTO classification, J Am Coll Cardiol 1997;30:649–56

MACCE to 2 Years by SYNTAX Score Tercile

Low Scores (0–22)

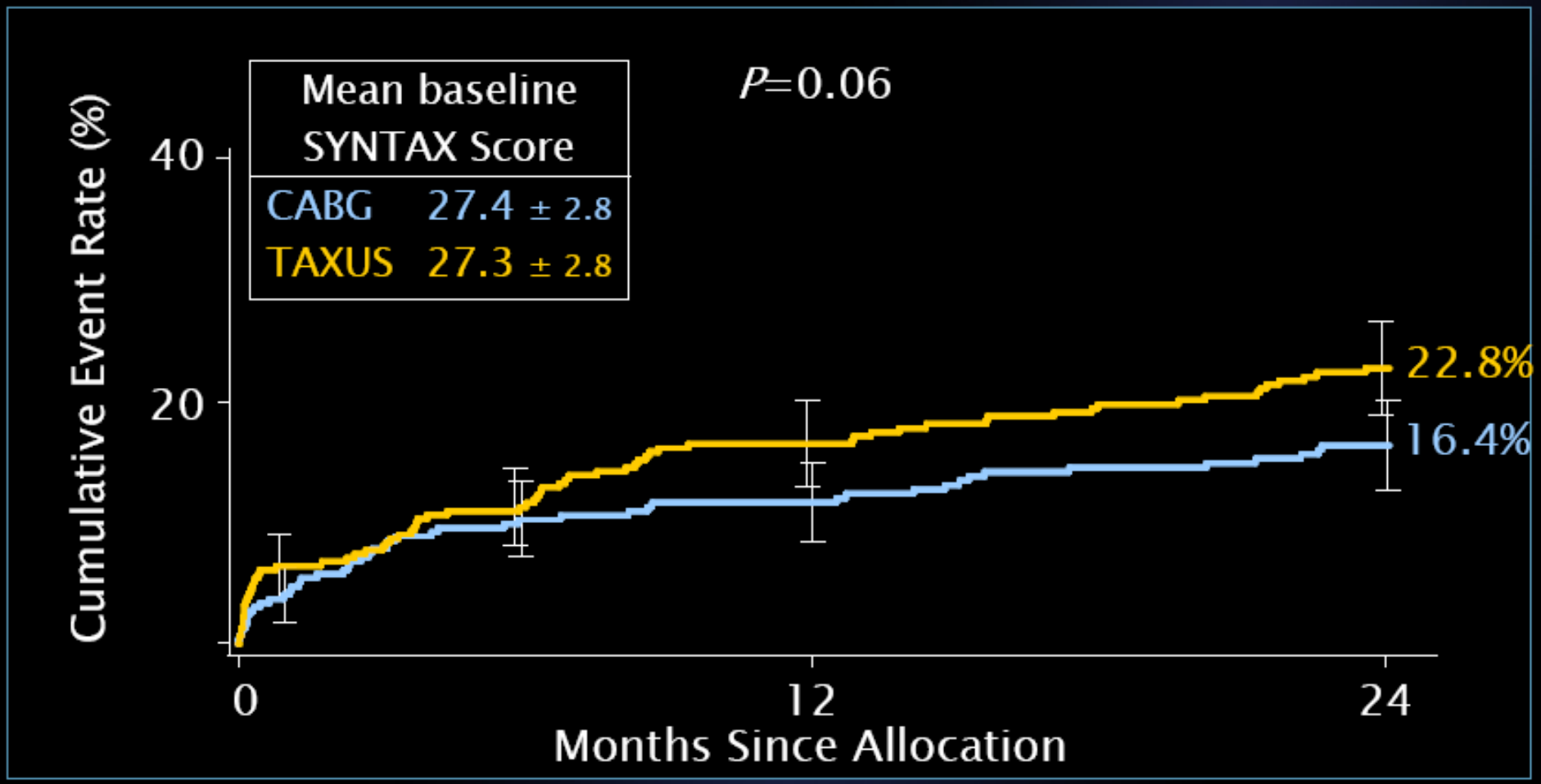


Cumulative KM Event Rate ± 1.5 SE; log-rank *P* value

Calculated by core laboratory; ITT population

MACCE to 2 Years by SYNTAX Score Tercile

Intermediate Scores (23–32)

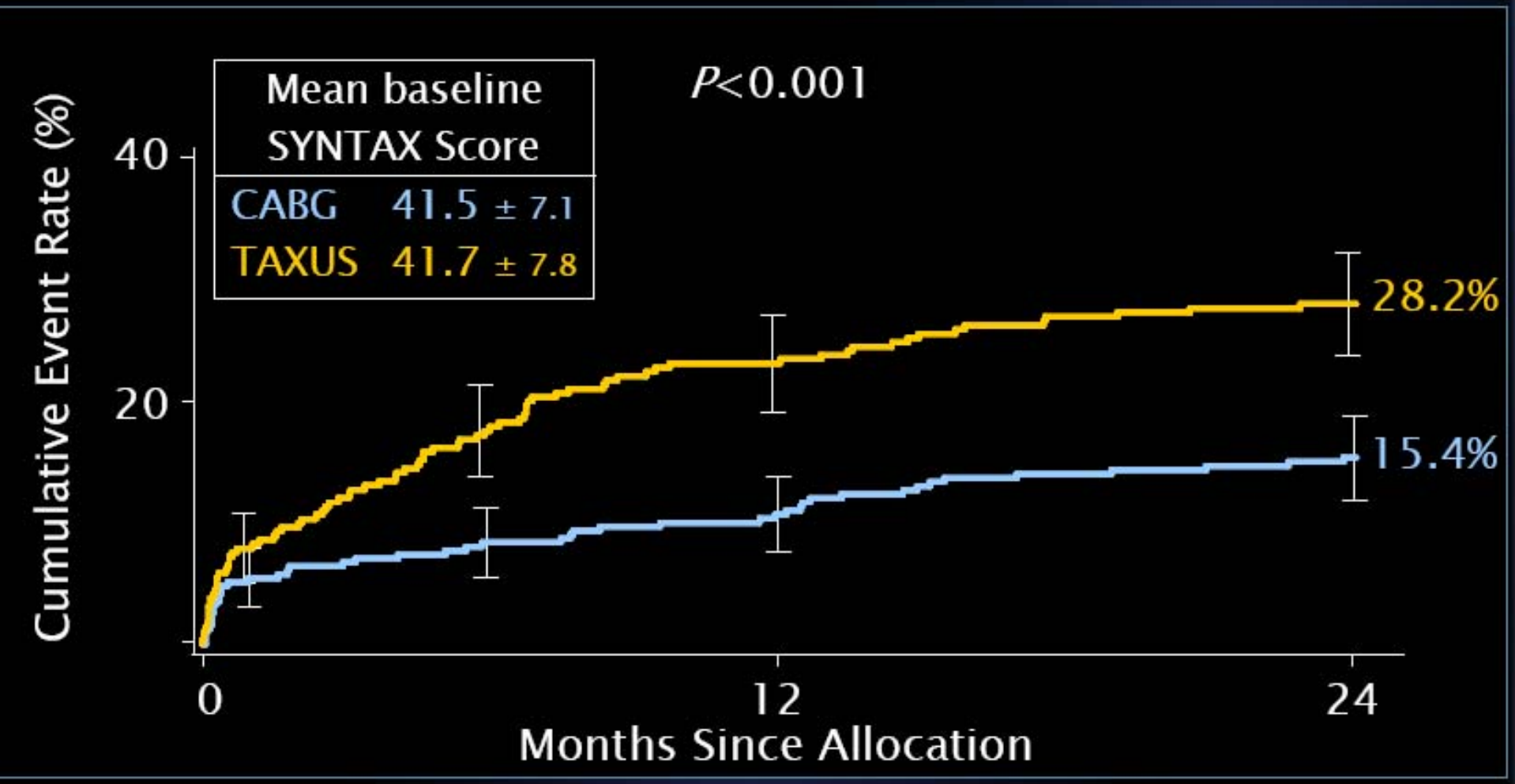


Cumulative KM Event Rate ± 1.5 SE; log-rank *P* value

Calculated by core laboratory; ITT population

MACCE to 2 Years by SYNTAX Score Tercile

High Scores (≥33)

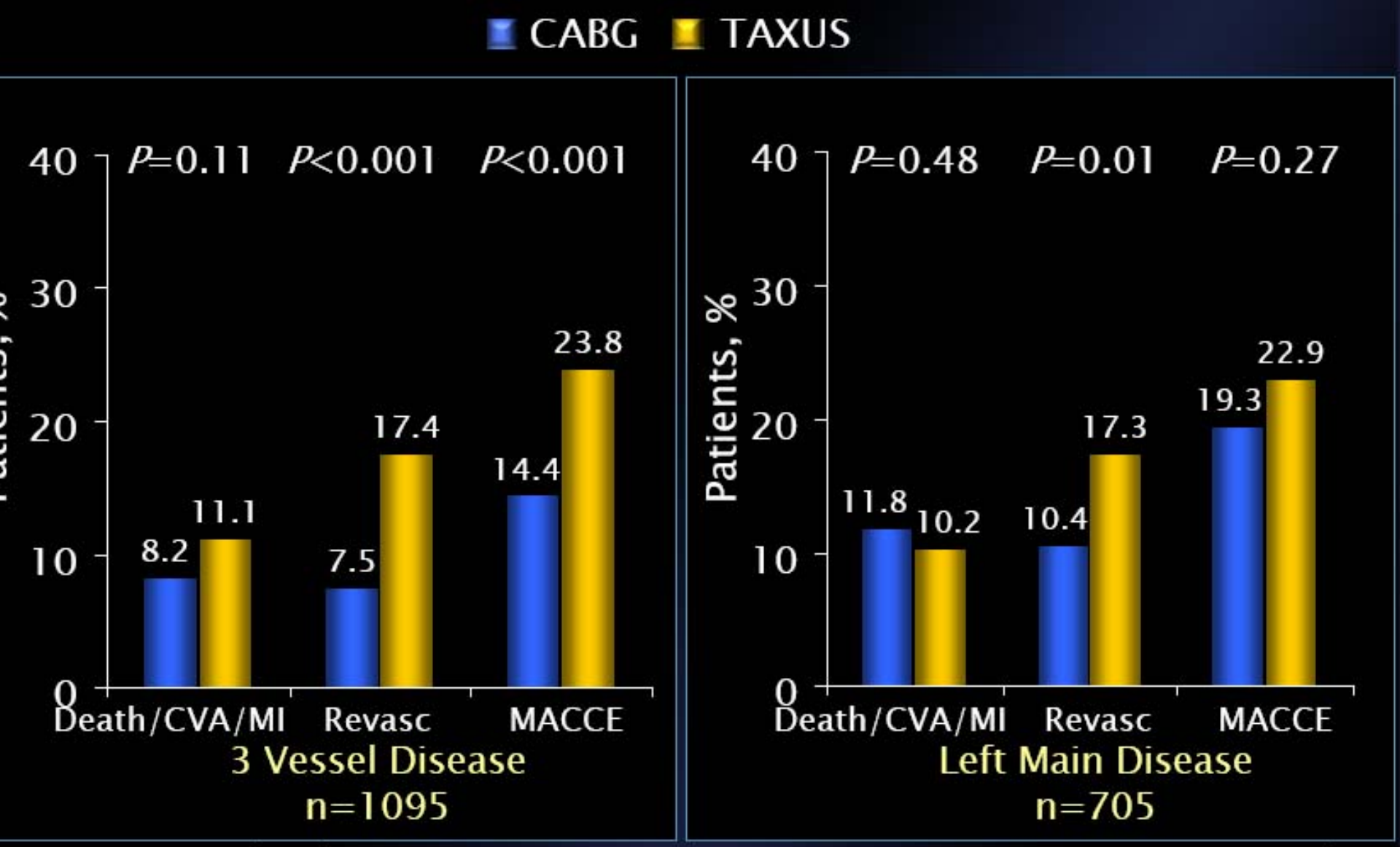


umulative KM Event Rate ± 1.5 SE; log-rank *P* value

Calculated by core laboratory; ITT population

2 Year Outcomes in 3VD and LM Subgroups

SYNTAX



ne-to Event: Log-rank *P* value

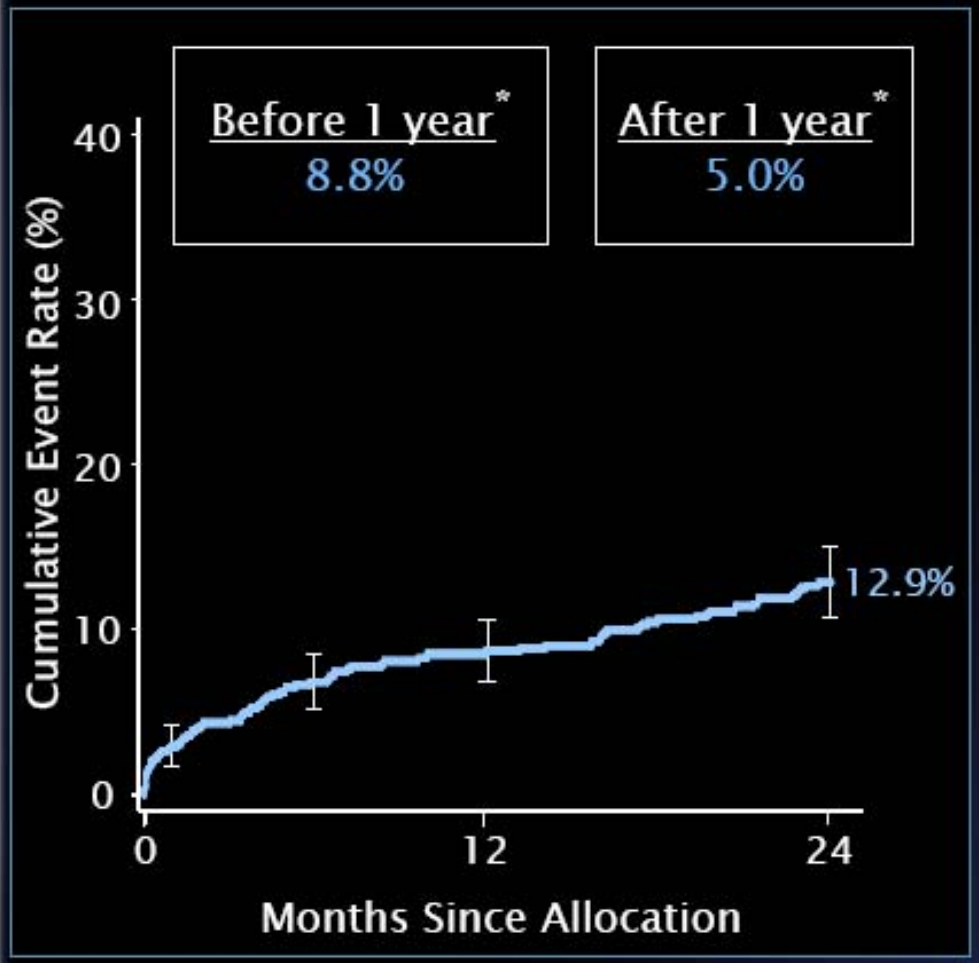
ITT population

MACCE to 2 Years

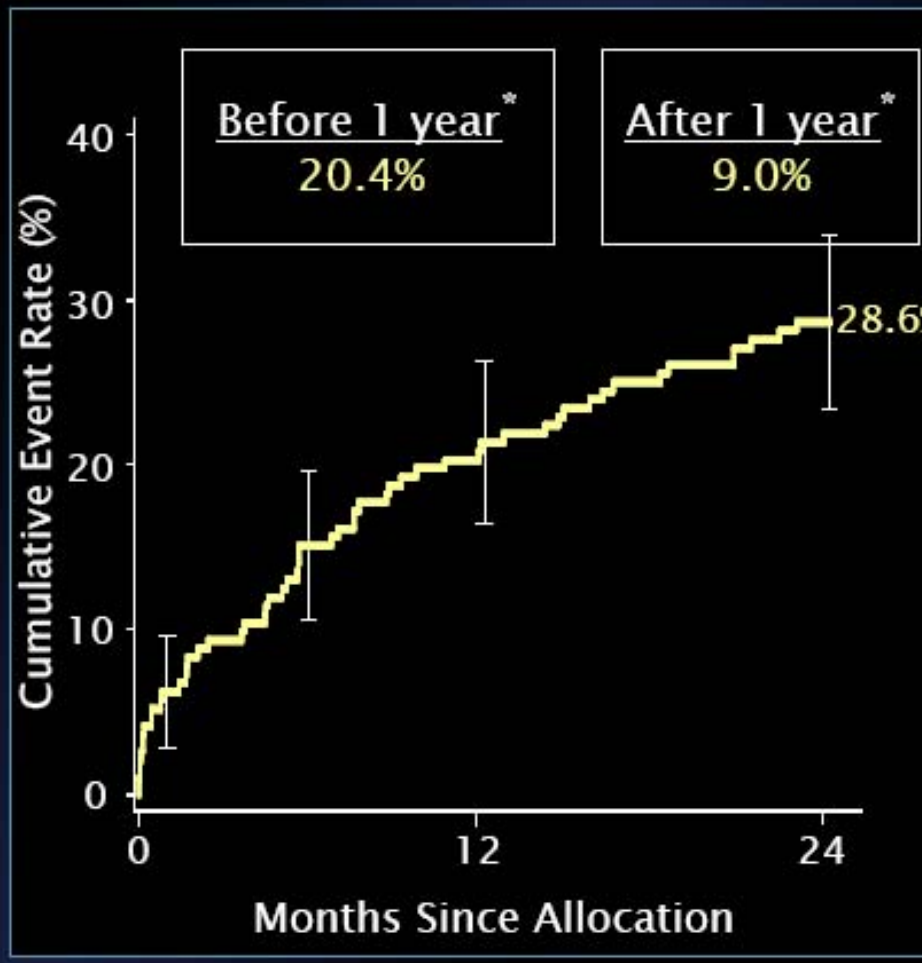
SYNTAX CABG and PCI Registries

SYNTAX

CABG Registry (N=644)



PCI Registry (N=192)



Cumulative KM Event Rate ± 1.5 SE; *intervals calculated as binary rates

Site-reported data; ITT populat

Reasons for a Survival Benefit of CABG vs. PCI

- placing bypass grafts to the mid coronary vessel
  - nullifies the complexity of proximal disease
  - protects whole zones of vulnerable proximal myocardium against the development of new proximal disease
- CABG allows more complete revascularization

Health economics

the benefits of CABG in survival and freedom from reintervention have led health economists to conclude that CABG remains a far more cost-effective therapy than PCI over the longer term

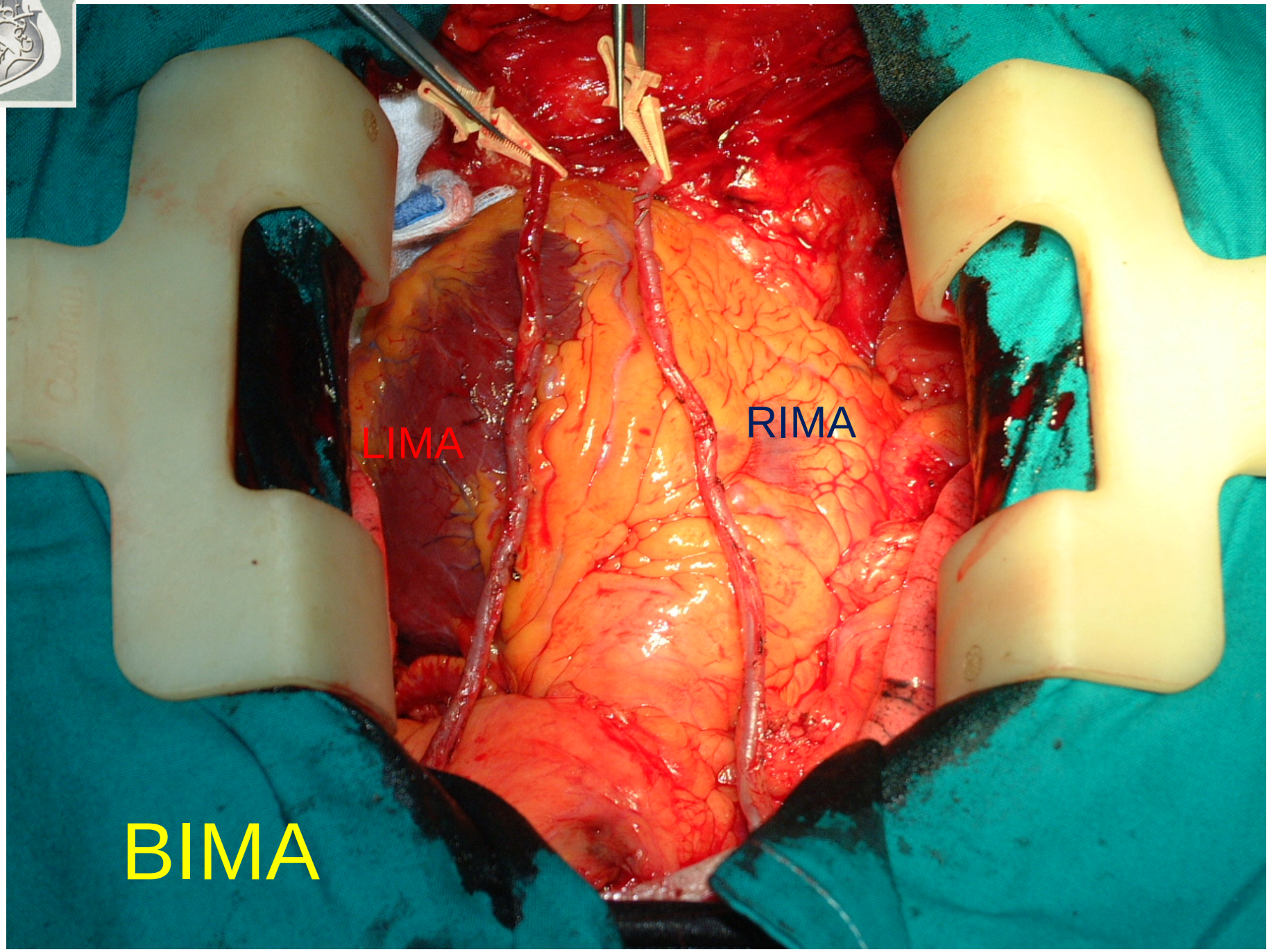
1. Hill R, Bagust A, Bakhai A, et al. Coronary artery stents: A rapid systematic review and economic evaluation. ***Health Technol Assess***. 2004;8:1–242.
2. Griffin SC, Barber JA, Manca A, et al. Cost effectiveness of clinically appropriate decisions on alternative treatments for angina pectoris: Prospective observational study. ***BMJ***. 2007;334:624–627

Need to Improve Surgery

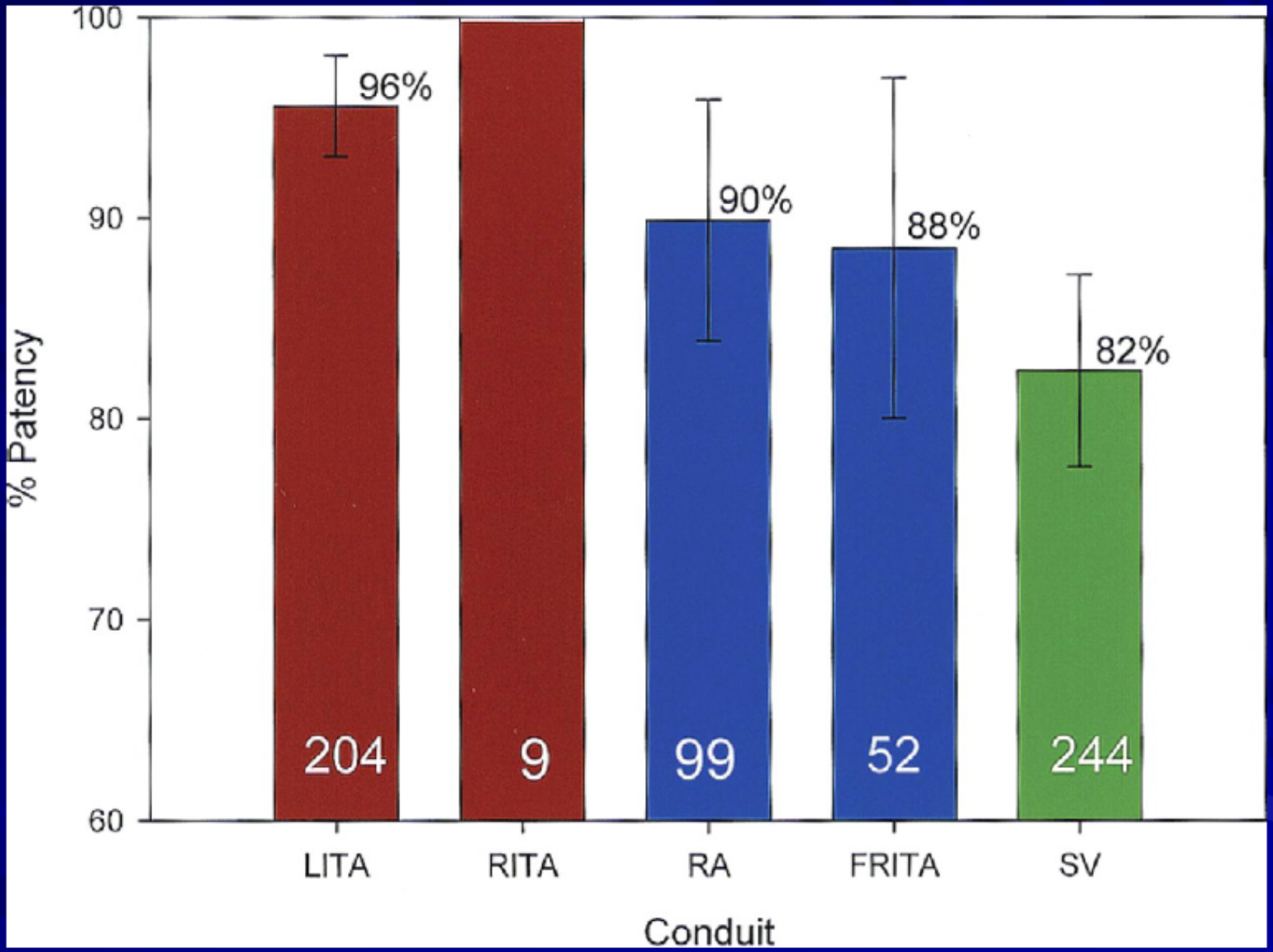
- Bilateral Internal Mamary Arteries
  (BIMA v. LIMA only)

- OPCAB v. ONCAB

- quality control of grafts

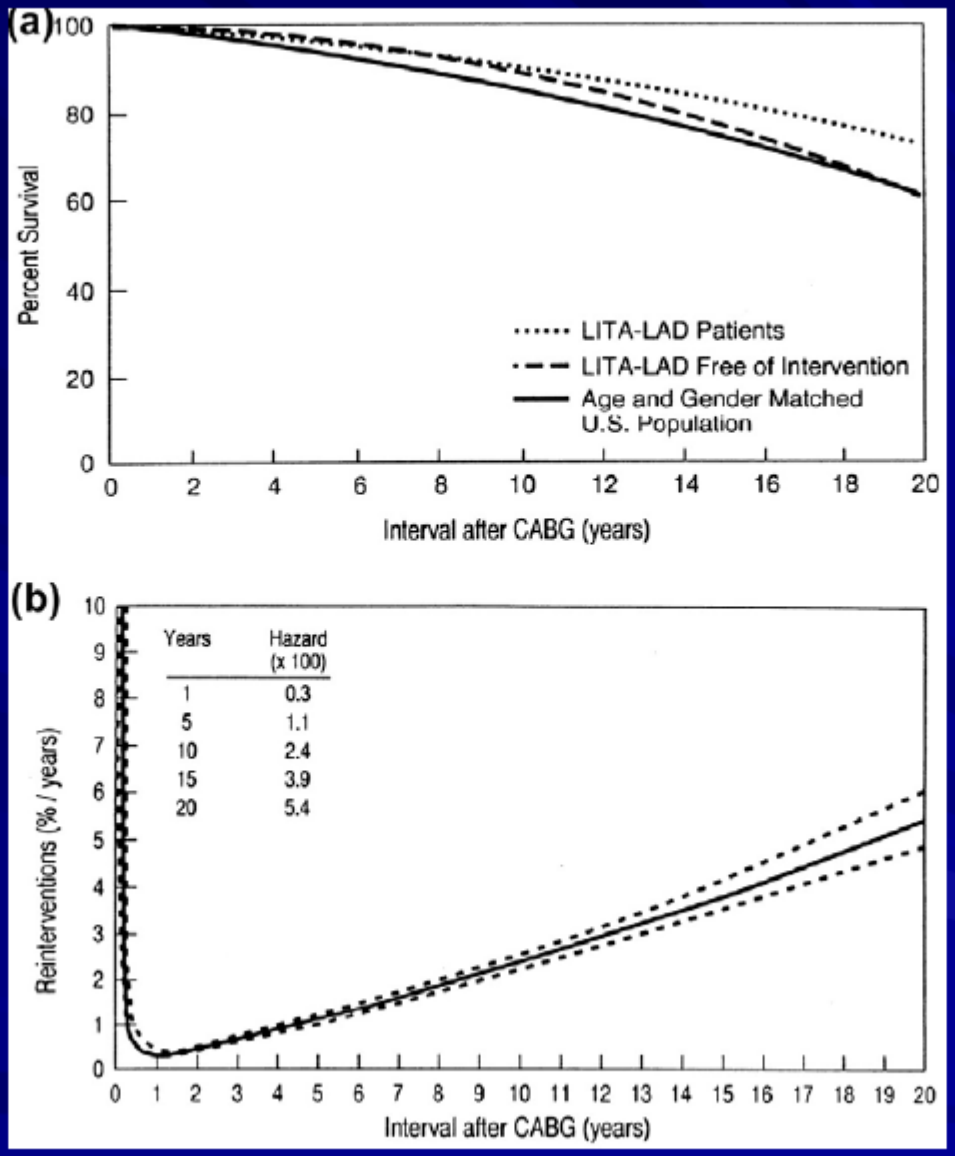

LIMA
RIMA
BIMA

Comparative patencies of different in situ and free arterial conduits at 5 years



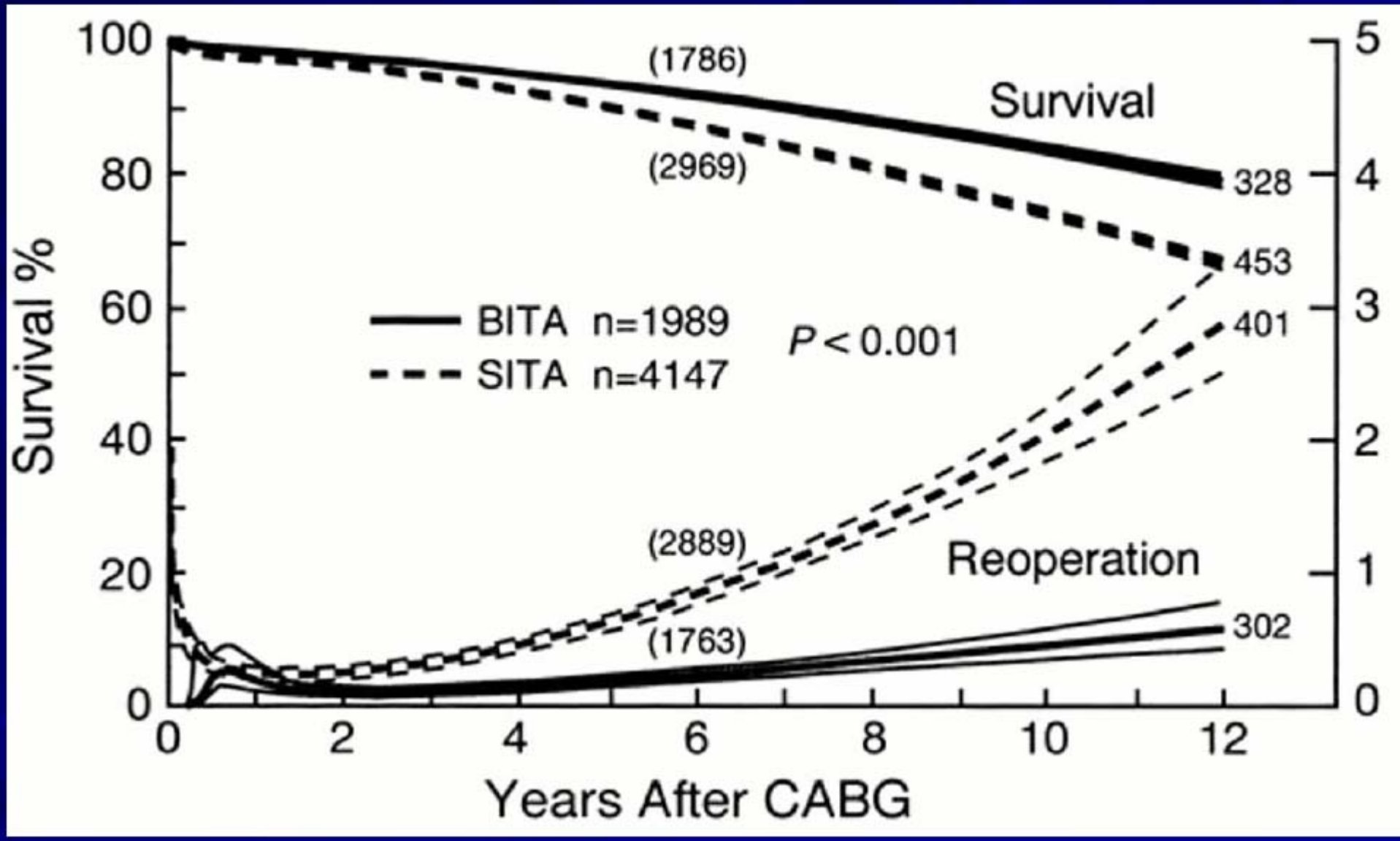
Hayward, P. A.R. et al.: Ann Thorac Surg 2007;84:795-799

(A) Twenty-year event-free survival after left internal thoracic artery grafting for s
vessel anterior descending disease compared with age and gender matched US popu

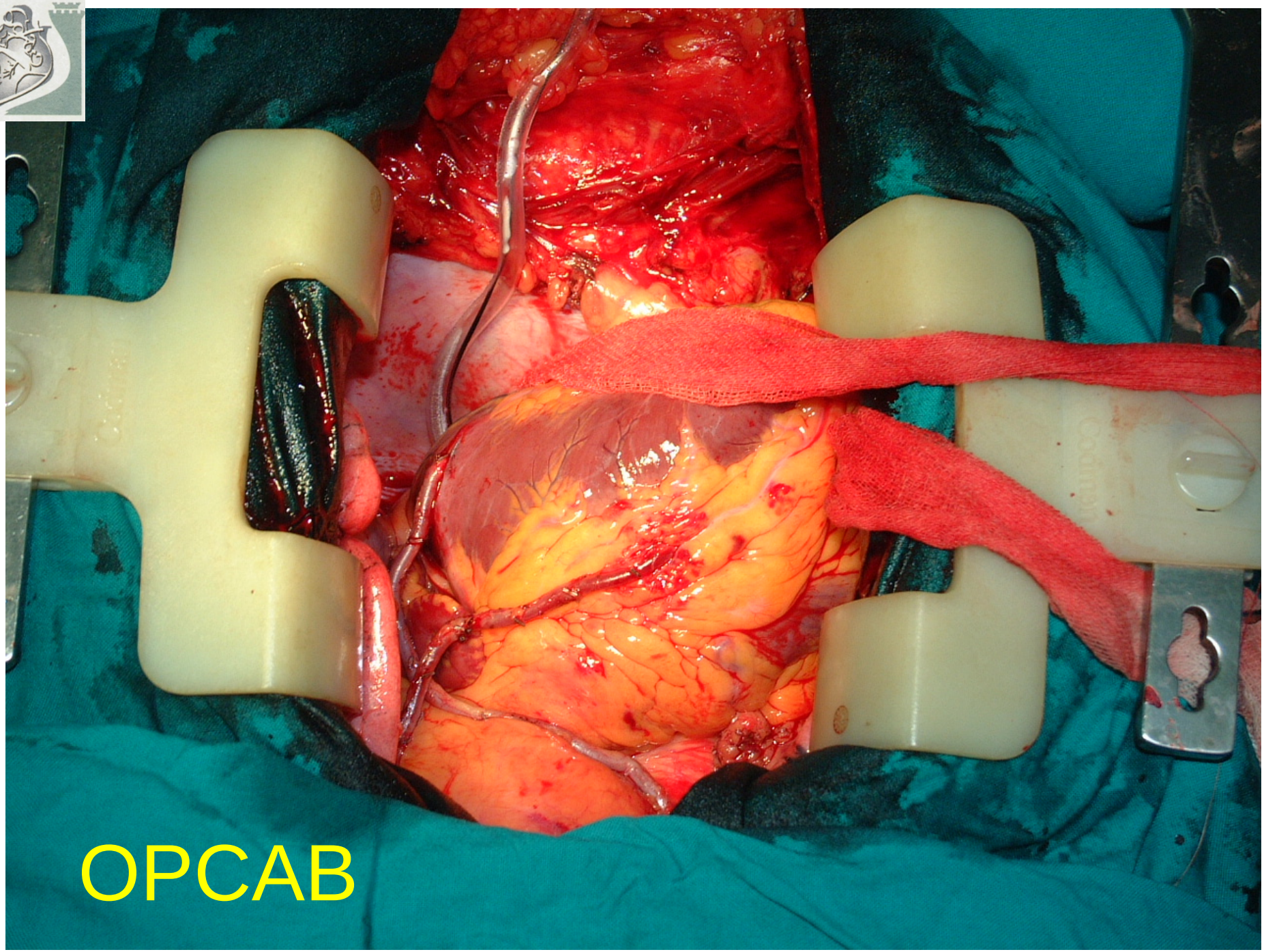


Loop F. D.; Eur J Cardiothorac Surg 1998;14:554-571

Bilateral vs. Single Mammary Artery Grafting



Lytle B. W. et al.; J Thorac Cardiovasc Surg 1999;117:855-872


OPCAB

STS database analysis
186,458 patients who underwent CABG
(65,864 OPCAB and 120,594 ONCAB)

Table 2 Risk-Adjusted Outcomes of OPCAB vs ONCAB

	OPCAB	ONCAB	*P*	Risk-Adjusted Odds Ratio (95% CI)
Operative mortality	1.52	1.69	0.0439	0.80 (0.73, 0.87)
MACE	2.84	3.82	<0.0001	0.68 (0.64, 0.73)
Stroke	0.85	1.35	<0.0001	0.62 (0.55, 0.68)
Dialysis	0.87	1.09	0.0007	
Reoperation	4.52	5.29	<0.0001	
Prolonged vent	7.18	8.98	<0.0001	
Renal failure	2.78	3.44	<0.0001	
Sternal failure	0.29	0.42	0.0001	
PLOS > 14 d	4.59	5.64	<0.0001	

CI, confidence interval; MACE, major adverse cardiac events; ONCAB, on-pump coronary artery bypass; OPCAB, off-pump coronary artery bypass; PLOS, postoperative length of stay.

Courtesy of John D. Puskas, MD.

Puskas JD: OPCAB: Is it a better strategy? Presented at STS/AATS Tech Con 2009

STS database analysis
186,458 patients who underwent CABG
(65,864 OPCAB and 120,594 ONCAB)

Table 3 Risk-Adjusted Outcomes of OPCAB vs ONCAB by Anatomic Group

	1-2 Vessel		3 Vessel w/o LM		3 Vessel w/LM	
	Adjusted Odds Ratio	Adjusted *P*	Adjusted Odds Ratio	Adjusted *P*	Adjusted Odds Ratio	Adjusted *P*
Operative mortality	0.80 (0.66, 0.95)	0.013	0.85 (0.66, 0.95)	0.006	0.81 (0.70, 0.94)	0.006
Permanent stroke	0.47 (0.37, 0.59)	<0.001	0.72 (0.62, 0.82)	<0.001	0.64 (0.53, 0.77)	<0.001
MI	0.59 (0.46, 0.75)	<0.001	0.63 (0.54, 0.74)	<0.001	0.69 (0.56, 0.85)	<0.001
MACE	0.63 (0.55, 0.71)	<0.001	0.74 (0.69, 0.81)	<0.001	0.72 (0.64, 0.80)	<0.001

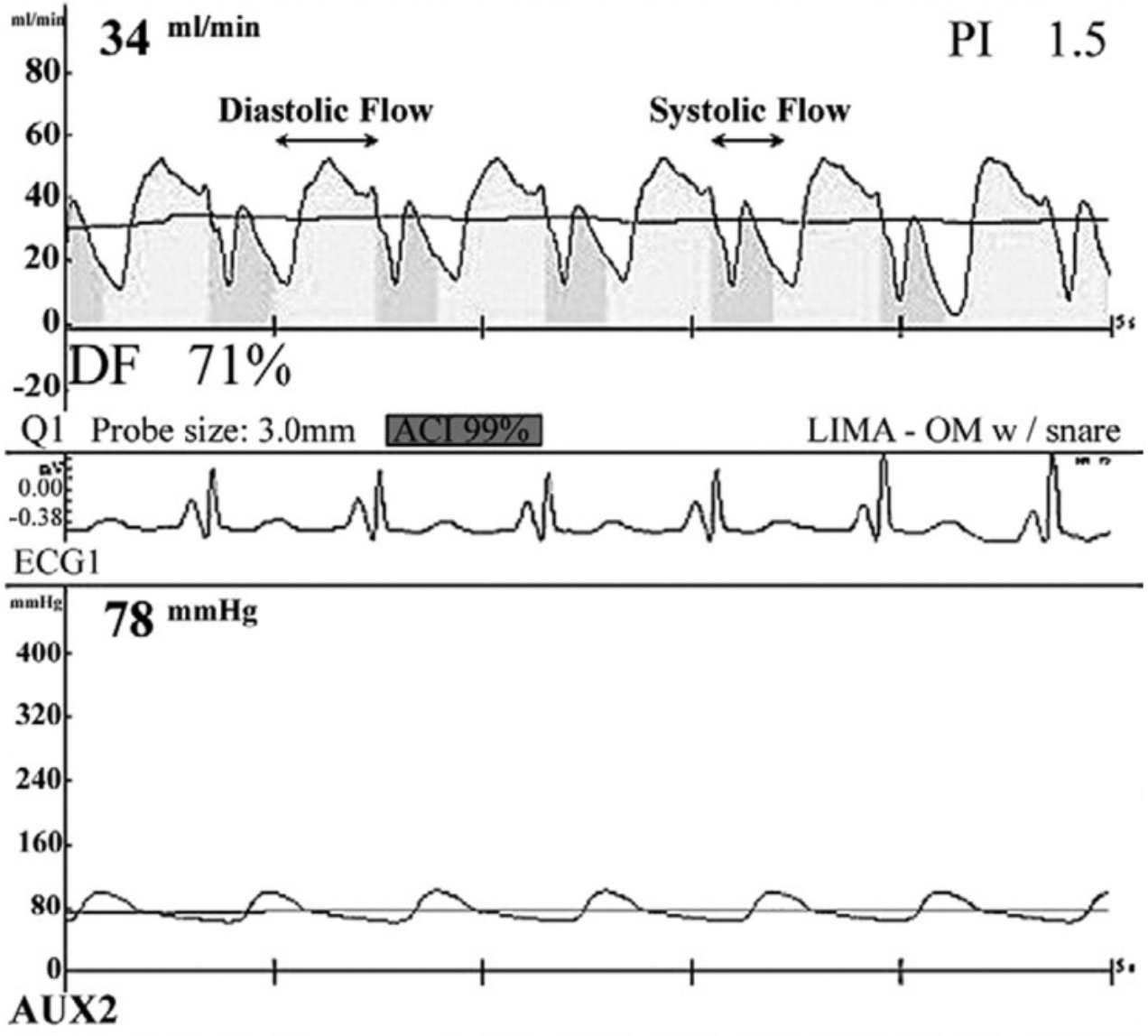
LM, left main disease; MACE, major adverse cardiac events; MI, myocardial infarction; ONCAB, on-pump coronary artery bypass; OPCAB, off-pump coronary artery bypass.

Courtesy of John D. Puskas, MD.

Puskas JD: OPCAB: Is it a better strategy? Presented at STS/AATS Tech Con 2009

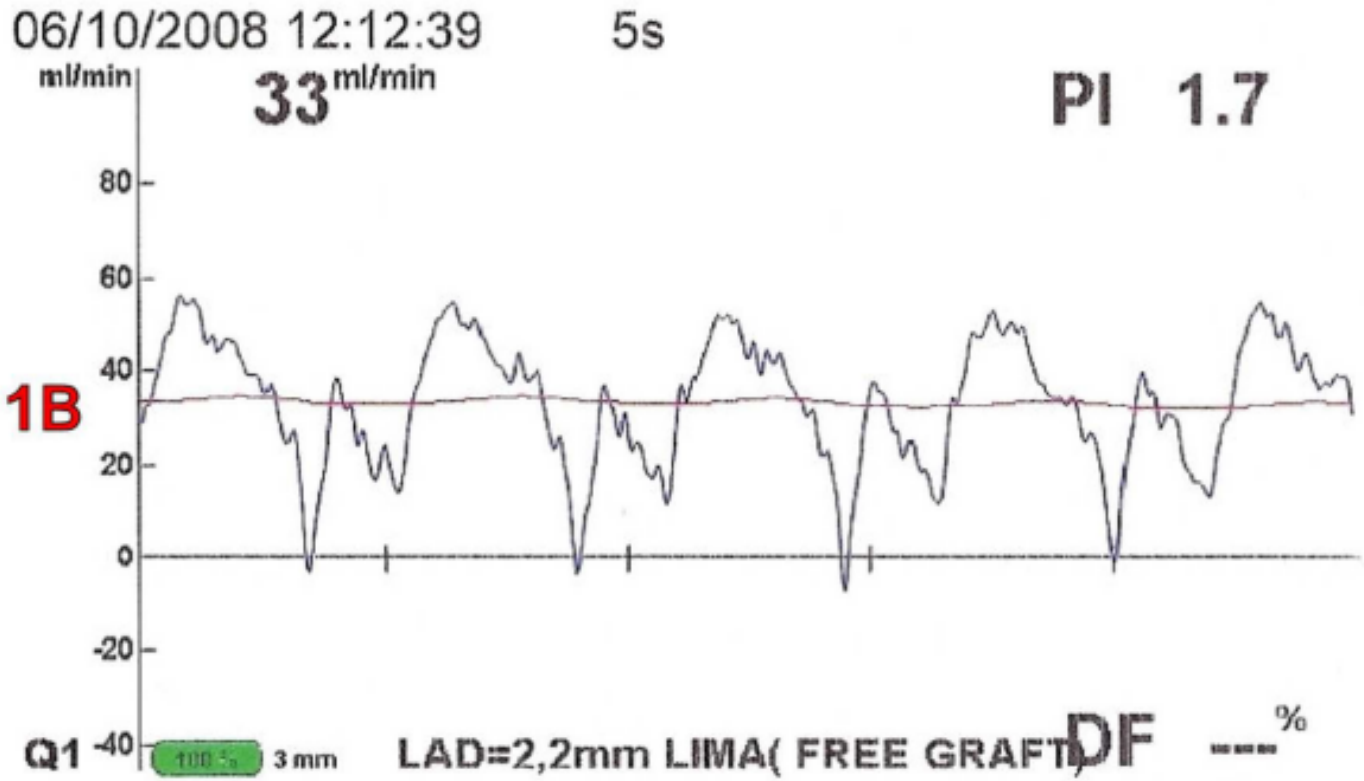
quality control

Transit-time flowmetry (TTFM) display

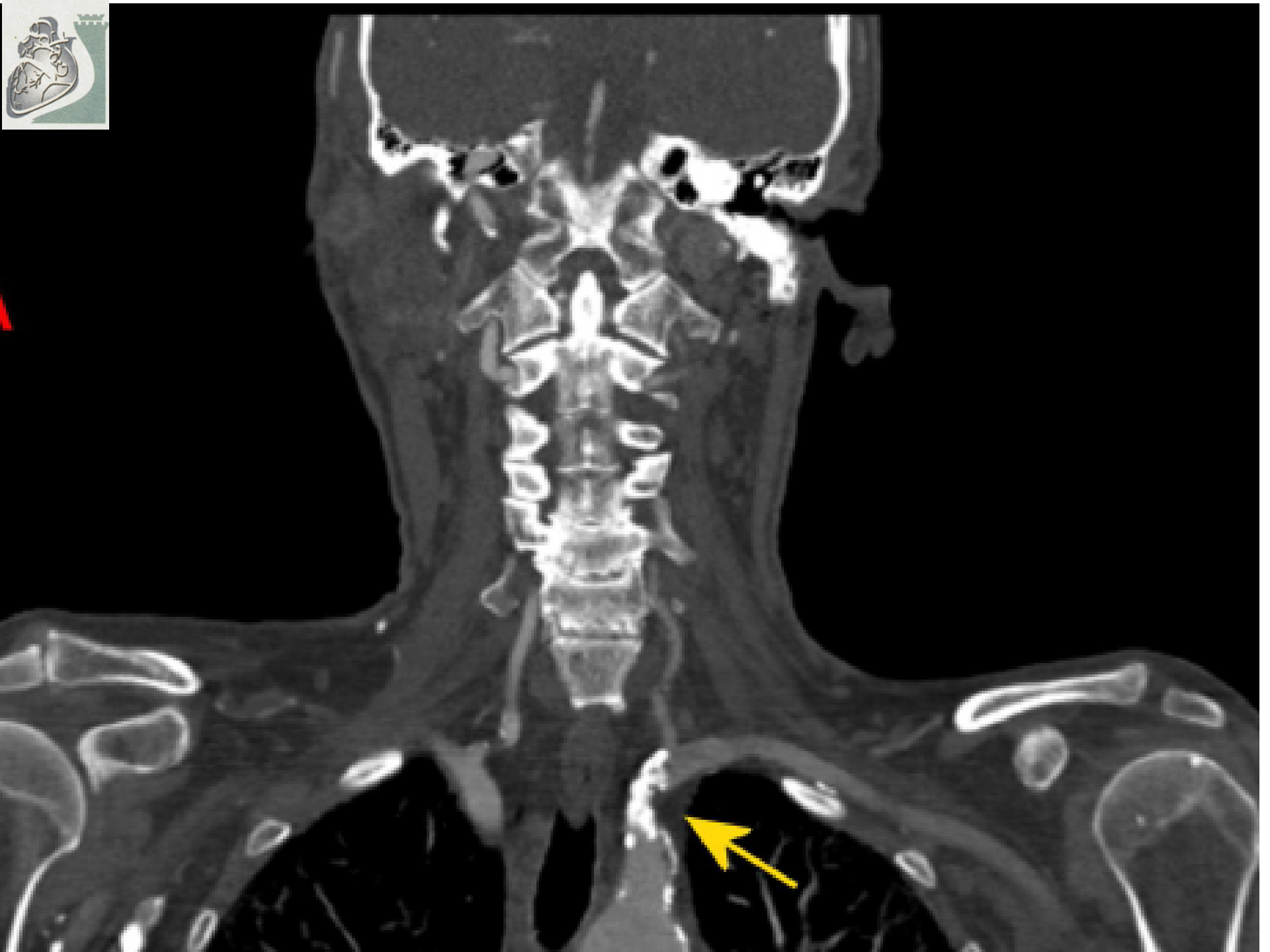


pedicled LIMA to LAD graft

free LIMA to LAD graft

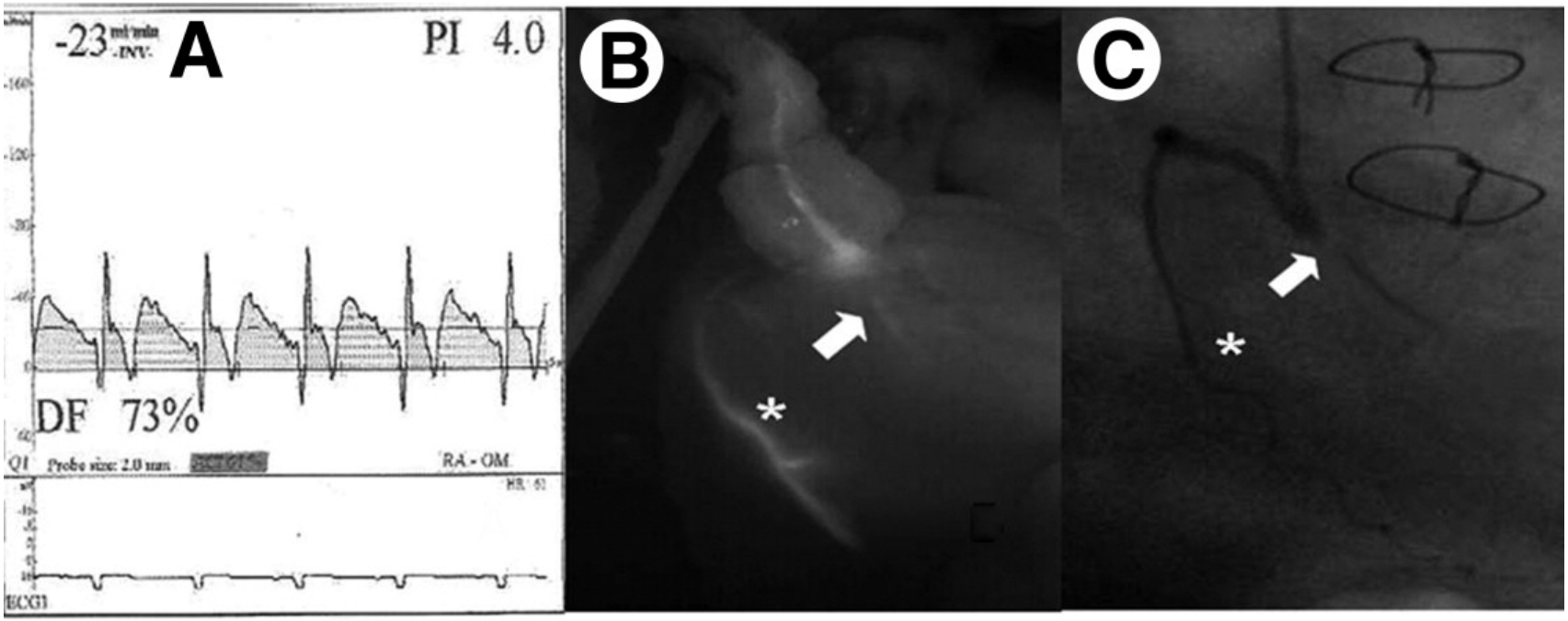


150x180mm (300 x 300 DPI)



2B

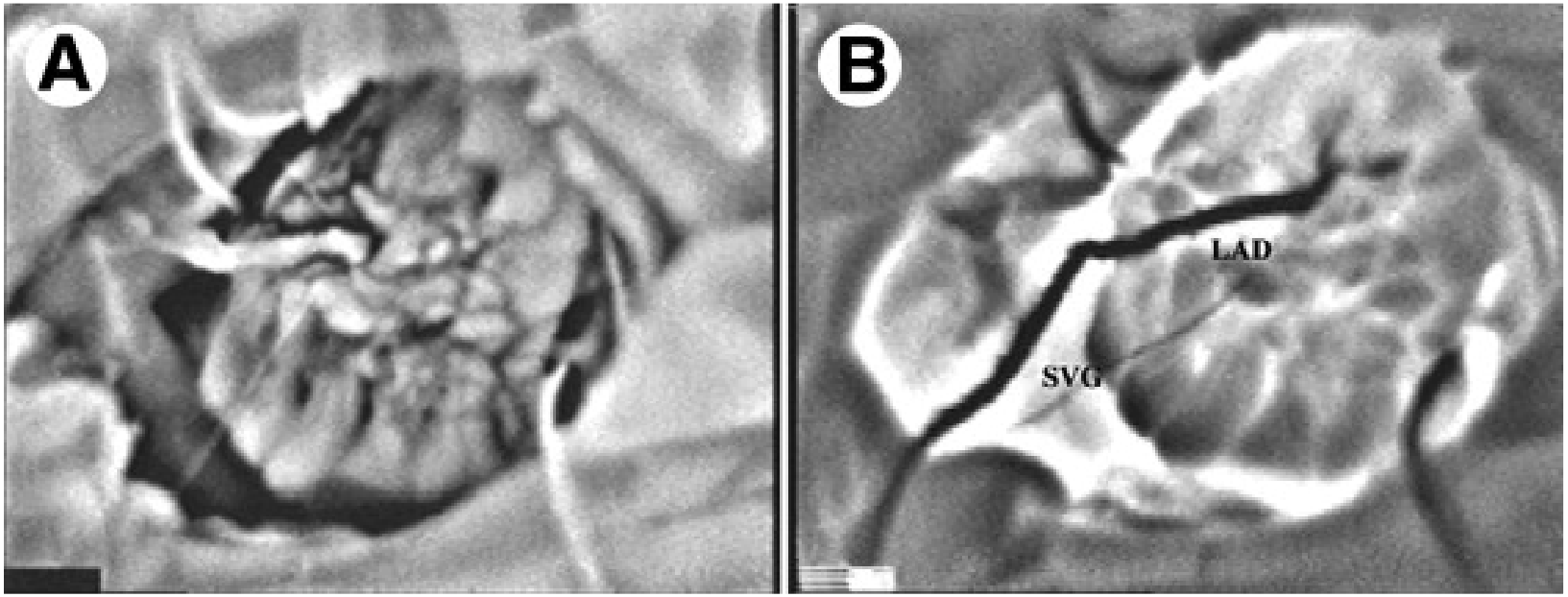
Intraoperative Fluorescence Imaging



Near total occluded radial artery graft to the first obtuse marginal anastomosis assessed by TTF assessment (A), ICG angiogram (B), and X-ray angiogram (C)

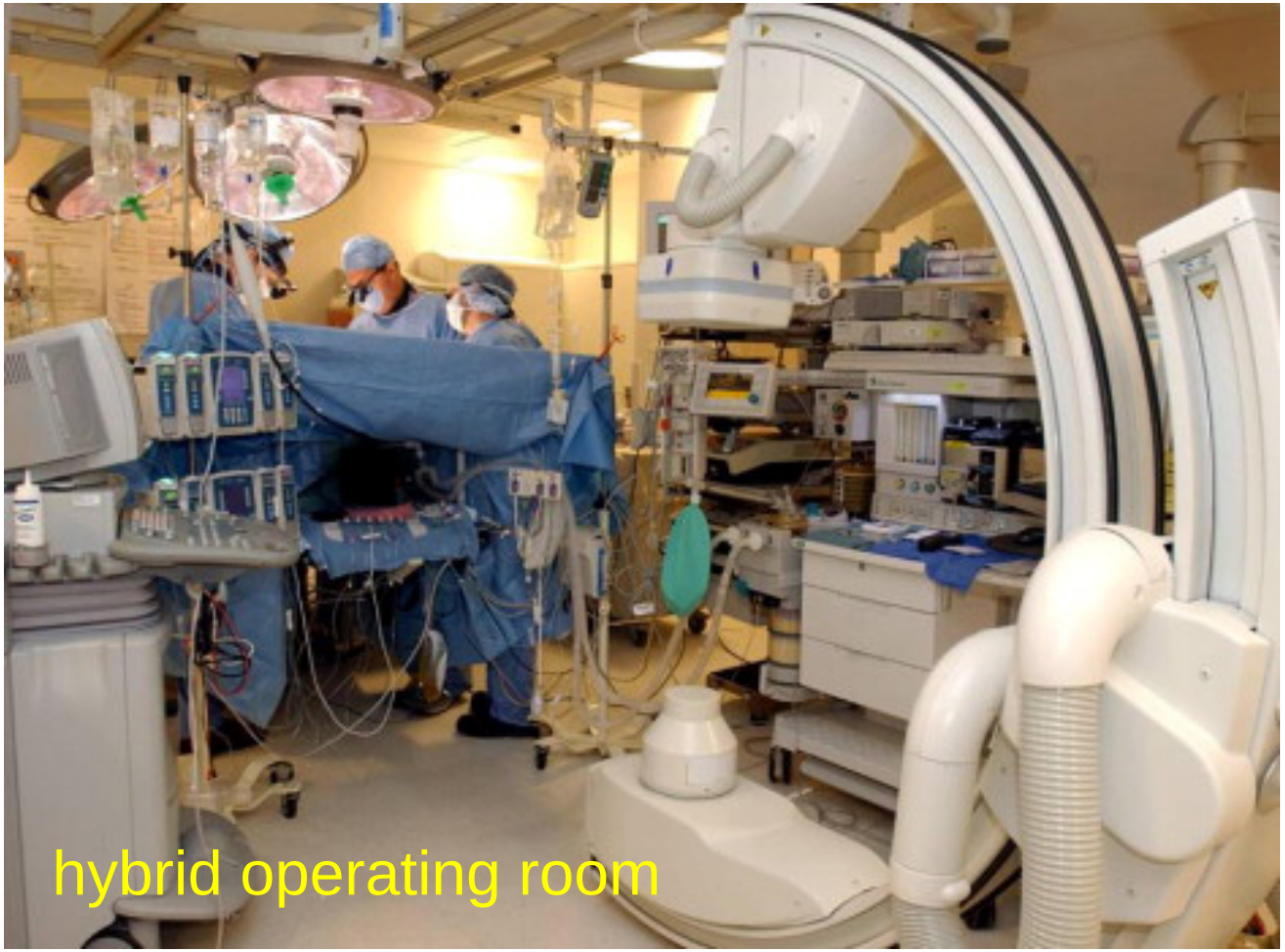
Seminars in Thoracic and Cardiovascular Surgery 2009; 21:207-212

Thermal coronary angiography

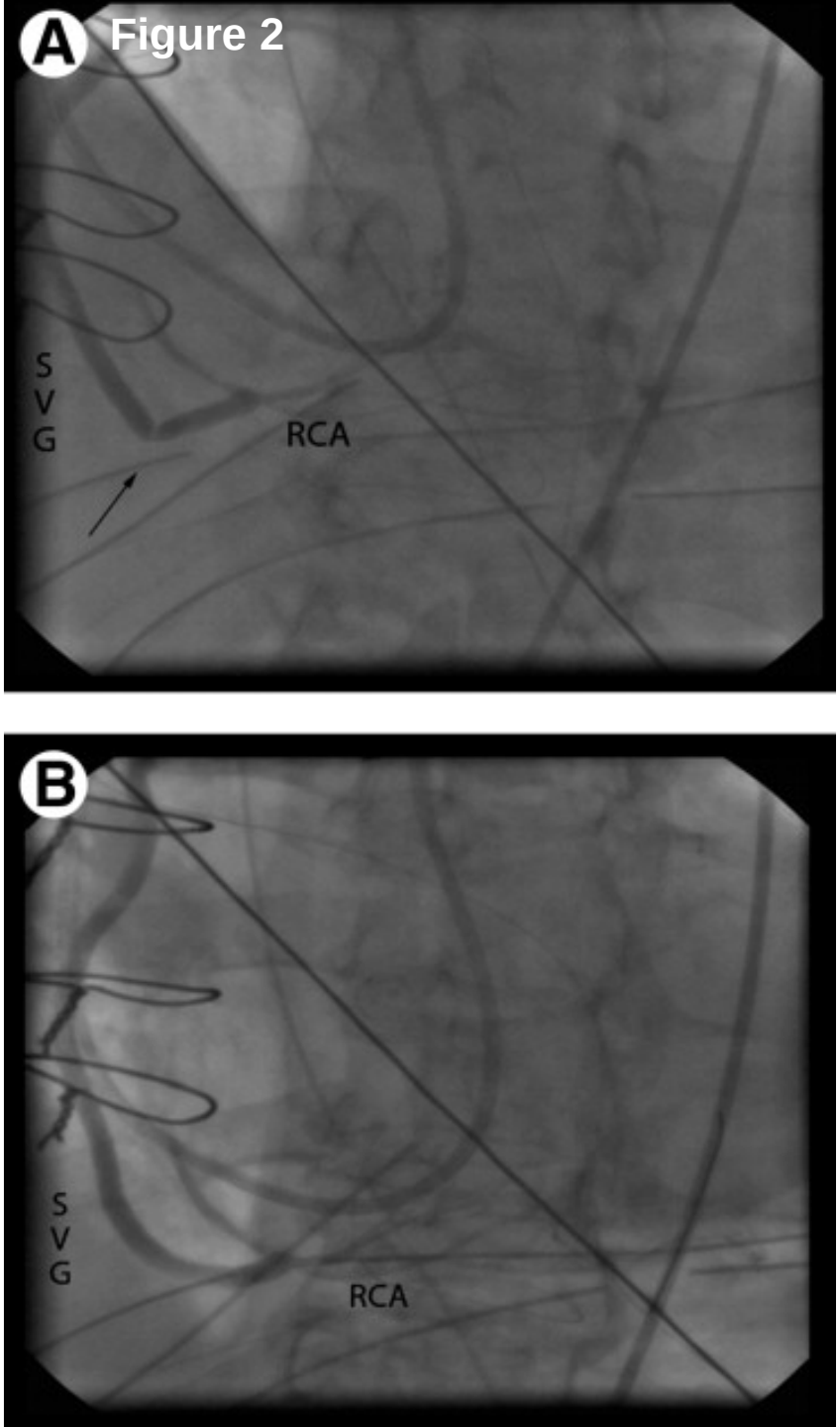


(A) Thermal coronary angiography showing an occluded left internal thoracic artery to left anterior descending coronary artery anastomosis. (B) The new graft, saphenous vein graft, to left anterior descending coronary artery (LAD), is patent (black line). Iwahashi et al,29 , 2007 The Society of Thoracic Surgeons.

completion coronary angiography



A saphenous vein graft to the right coronary artery graft with a kink (arrows) before (A) and (B) after revision.



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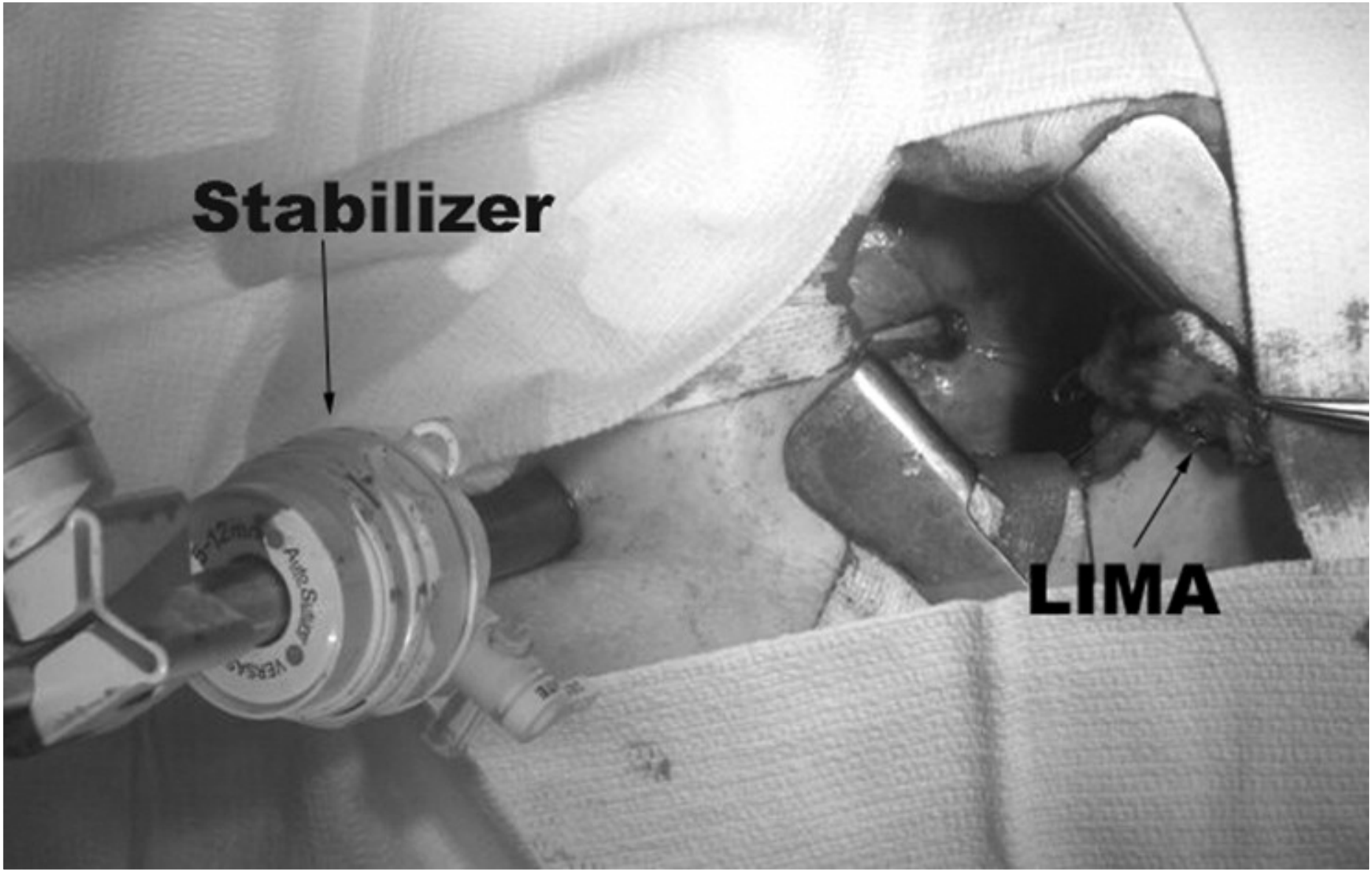
Operative setup for robotic MidCAB showing endoscopic stabilizer delivered through the left robotic arm port



INTUITIVE
SURGICAL

C-Port xA

C-Port FlexA

C-Port

X-CHANGE

“Hybrid” Coronary Revascularization

HCR Strategy	Advantages	Disadvantages
PCI followed by minimally invasive CABG	1. Minimize risk of ischemia during minimally invasive CABG 2. Conventional CABG as fallback if suboptimal PCI result 3. HCR is possible in the setting of PCI for MI in non-LAD targets	1. Risk of stent thrombosis with discontinuation of antiplatelet inhibitors and inflammation of minimally invasive CABG 2. Increased bleeding if minimally invasive CABG performed on dual antiplatelet therapy 3. Cannot routinely image LIMA-LAD
Minimally invasive CABG followed by PCI	1. Aggressive continuous antiplatelet therapy following PCI 2. Routine angiography of LIMA-LAD 3. PCI of high risk lesions is possible with a patent LIMA-LAD	1. Minimally invasive CABG is performed in the setting of residual coronary lesions 2. Fallback conventional CABG holds higher morbidity if suboptimal PCI result
Simultaneous minimally invasive CABG and PCI	1. Immediate angiography of LIMA-LAD 2. Aggressive PCI of high-risk lesions with a documented patent LIMA-LAD 3. Complete revascularization out of operating room	1. Bleeding risk with dual antiplatelet therapy at the time of surgery 2. Risk of stent thrombosis in setting of inflammatory response of surgery 3. Economic and logistic issues

“Hybrid” Coronary Revascularization

Author	Institution	Date	n	MICABG	PCI	HCR Strategy	F/U	30-day Mortality (%)	LIMA Patency (%)	TVR	Event-Free Survival
Zenati[22]	Pittsburgh	1999	31	Open MidCAB	BMS—66% PTCA—34%	PCI then MICABG 7% Same day—52% MICABG then PCI—9%	10.8 mo	0	100	9.6	90
Lloyd[23]	Bristol Heart	1999	18	Open MidCAB	PTCA—52% BMS—48%	MICABG then PCI—77% Simultaneous—23%	6 mo	0	100	0	100
Wittwer[24]	Hannover	2000	35	Open MidCAB	PTCA—70% BMS—30%	MICABG then PCI	11.5 d	0	100	NA	NA
Riess[25]	Hamburg	2002	57	Lower Hemi-sternotomy	PTCA—58% BMS—42%	MICABG then PCI	24 mo	0	97	16	NA
Stahl[26]	Multi-USA	2002	54	Robotic Endo-ACAB	PTCA	PCI then MICABG—35% MICABG then PCI—65%	11.7 mo	0	100	NA	87
Cisowski[27]	Poland	2002	50	Thoracoscopic MidCAB	PTCA—22% BMS—78%	MICABG then PCI	6-24 mo	0	100	13	87
Davidavicius[14]	Belgium	2005	20	Robotic Endo-ACAB	BMS—95% DES—5%	PCI then MICABG—70% MICABG then PCI—30%	19 mo	0	100	0	100
Katz[28]	Multi-International	2006	27	Arrested heart TECAB	BMS—37% DES—63%	PCI then MICABG—41% MICABG then PCI—44% Simultaneous—15%	9 mo	0	100	29.6	70
Vassiliades[29]	Emory	2006	47	Thoracoscopic Endo-ACAB	DES	PCI then MICABG—11% MICABG then PCI—89%	7 mo	0	100	8.5	89
Gilard[30]	France	2007	70	Conventional On pump CABG	Stent to RCA	CABG then PCI	33 mo	1.4	100	NA	96
Kon[21]	Maryland	2008	15	Open MidCAB	DES	Simultaneous	12 mo	0	100	6.7	93
Kiaii[17]	Western Ontario Canada	2008	58	Robotic Endo-ACAB	DES—90% BMS—10%	Simultaneous	20 mo	0	93	10.3	NA
Gao[18]	China	2009	10	Robotic MidCAB-6 Beating heart TECAB-4	BMS—67% DES—23%	MICABG, then PCI	5 mo	0	100	NA	NA

BMS, bare metal stent; DES, drug-eluting stent; endo-ACAB, endoscopic atraumatic coronary artery bypass; HCR, hybrid coronary revascularization; LIMA, left internal mammary artery; MidCAB, minimally invasive direct coronary artery bypass; MICABG, minimally invasive coronary artery bypass grafting; PCI, percutaneous coronary intervention; PTCA, percutaneous transluminal coronary angioplasty; RCA, right coronary artery; TECAB, totally endoscopic coronary artery bypass; TVR, target vessel revascularization.

Σταθερή Πολυαγγειακή Στεφανιαία Νόσος.

Ποιά είναι η καλύτερη θεραπεία μετά τις μελέτες COURAGE και SYNTAX;

Ποιοί ασθενείς πρέπει να υποβληθούν σε CABG;

- **LMS 50%**
- **Ισοδύναμο στελέχους με 70% LAD και 70% Cx**
- **Νόσος 3 αγγείων, και κυρίως αν συνδιάζεται με ελαττωμένο κλάσμα εξώθησης**

Stenting is highly effective

1. Acute MI
2. Unstable coronary syndromes
3. Cardiogenic shock
4. 1- and 2- VD without proximal LAD disease

PCI - Appeal to Patients

- Experience from consent attempts in RCTs
  - Shorter hospital stay
  - Reduced immediate procedural morbidity
  - Avoids GA, scars etc
  - Rapid rehabilitation
  - CABG option *usually* remains (short or long term)

Transparency – informed consent

all patients with complex coronary disease should have a treatment plan recommended by a multidisciplinary team

Summary: I

SYNTAX

- In the SYNTAX randomized patients, 2-year MACCE rates were significantly higher for PCI than CABG, mainly driven by higher repeat revascularization in the PCI arm.
  - Significant increase of MI compared to CABG at 2 years driven by higher PCI MI rate between years 1 and 2
  - Significantly higher CVA rate in CABG compared to PCI with the majority of CVAs occurring in the first year
  - Composite safety (death/CVA/MI) remains similar between arms at 2 years
- MACCE rates at 2 years not significantly different for patients with a low (0–22) or intermediate (23–32) baseline SYNTAX Score; for patients with high SYNTAX Scores (≥33), MACCE continued to be increased at 2 years in patients treated with PCI

Summary: II

SYNTAX

- In the predefined subgroups of patients with either 3VD or LM disease:
  - Safety outcomes (death/CVA/MI) in the 3VD group were similar for PCI and CABG, but the 2-year revascularization and MACCE rates favored CABG.
  - In the LM group, safety outcomes and MACCE rates were similar for PCI and CABG, but the 2-year revascularization rate was lower in the CABG group.
- The 2-year SYNTAX results suggest that CABG remains the standard of care for patients with complex disease (high SYNTAX Scores); however, PCI may be an acceptable alternative revascularization method to CABG when treating patients with less complex (low or intermediate SYNTAX Score) disease.
- The 2-year MACCE rates for the CABG and PCI registry were 12.9% and 28.6% respectively
- SYNTAX patients will continue to be followed for 5 years.

Two-year outcomes for SYNTAX

End point	CABG (%)	PCI (%)	p
All-cause death	4.9	6.2	0.24
All stroke	2.8	1.4	0.03
Stroke before 1 y	2.2	0.6	0.003
Stroke after 1 y	0.6	0.7	0.82
MI	3.3	5.9	0.01
MI before 1 y	3.3	4.8	0.11
MI after 1 y	0.1	1.2	0.008
All-cause death, stroke, MI	9.6	10.8	0.44
Repeat PCI	8.6	17.4	<0.001
MACCE	16.3	23.4	<0.001

Kappetein AP. European Society of Cardiology 2009 Congress; September 2, 2009: Barcelona, Spain.

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