המרכז הרפואי האוניברסיטאי סורוקה
Soroka University Medical Center

CABG - update

Sahar Gideon MD

מנהל המחלקה לניתוחי לב

המרכז הרפואי סורוקה

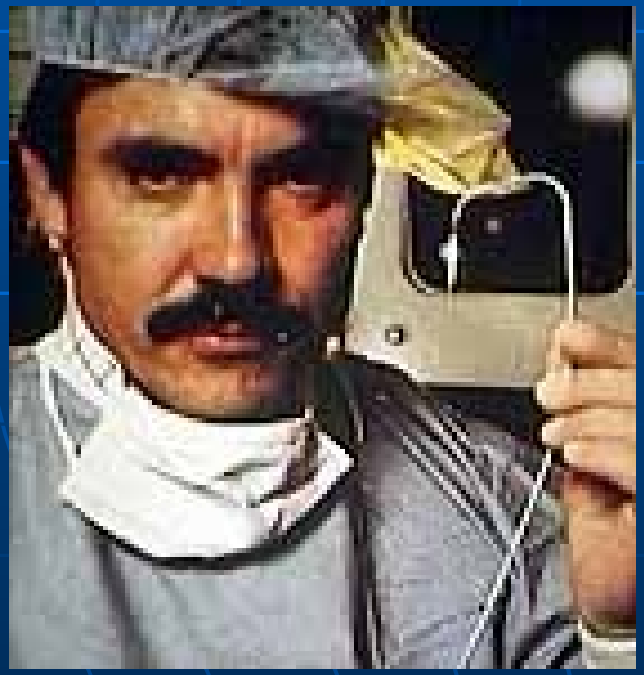
השתלמות לבוגרי התמחות בקרדיולוגיה

2008

Percutaneous Coronary Interventions ((PCI

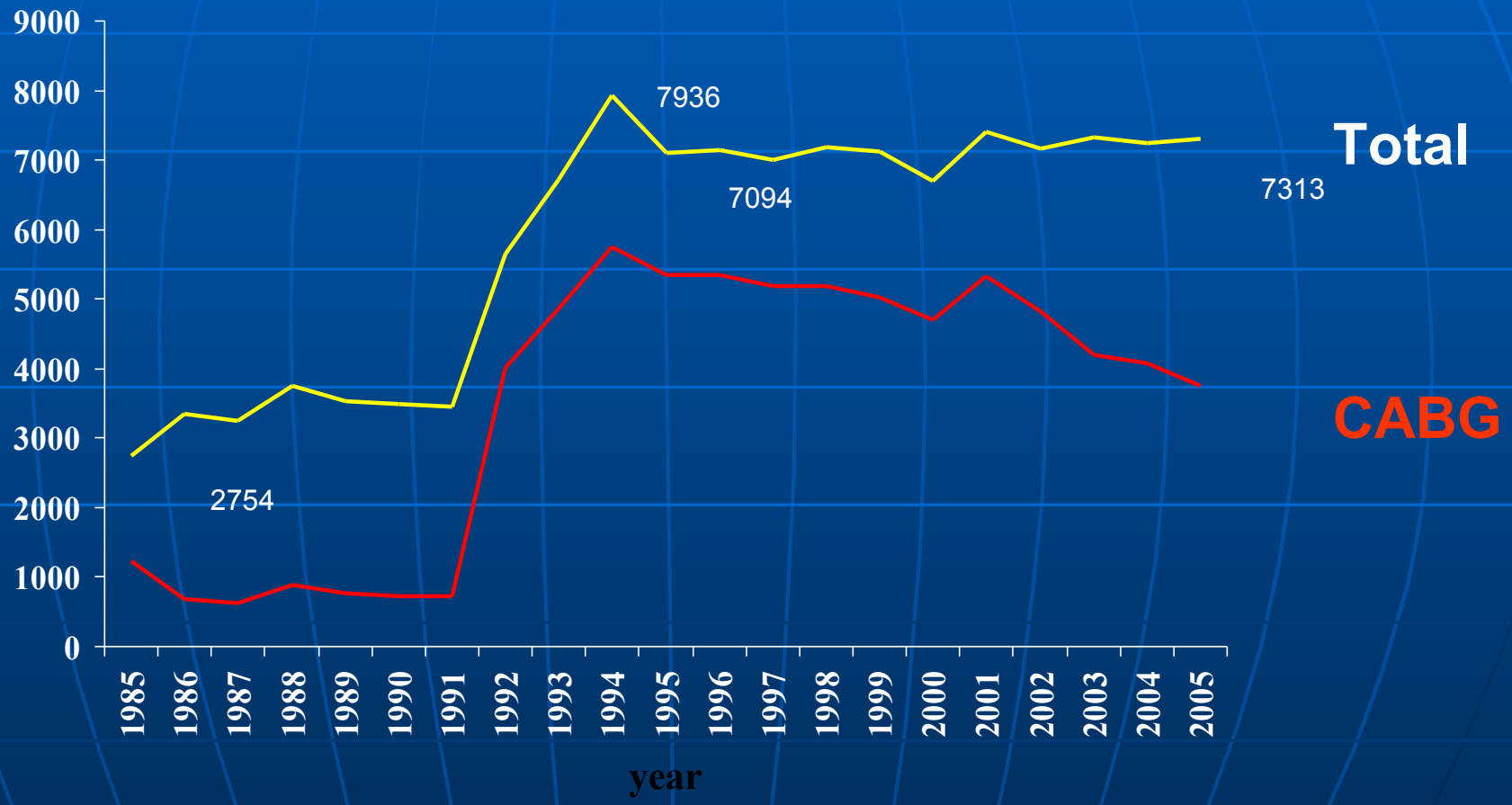
1 :1977st Coronary angioplasty by Gruntzig

Limitation: restenosis



1939-1985

Open Heart Surgery - Israel 1985-2005




baby gap

PCI vs CABG Trial Results Summary

Superior treatment modality — CABG | PCI | No difference

		Mortality & MI	Angina relief	Repeat revascularization	Stroke
No stents used	GABI	No difference	No difference	CABG	n/a
	EAST	No difference	CABG	CABG	No difference
	RITA	No difference	CABG	CABG	n/a
	ERACI	No difference	CABG	CABG	n/a
	CABRI	No difference	CABG	CABG	n/a
	BARI	No difference	No difference	CABG	n/a
BMS stents used	MASS-II	CABG (MI)	No difference	CABG	No difference
	AWESOME	No difference	No difference	CABG	No difference
	ERACI-II	PCI	n/a	CABG	n/a
	SoS	CABG (mortality)	CABG	CABG	n/a
	ARTS-I	No difference	n/a	CABG	No difference
DES stents used	ARTS-II	No difference	n/a	CABG	No difference
	MAIN-COMPARE	No difference	n/a	CABG	No difference
	LE MANS	No difference	No difference	CABG	No difference

A Meta-Analysis of Randomized Controlled Trials Comparing Coronary Artery Bypass Graft With Percutaneous Transluminal Coronary Angioplasty: One- to Eight-Year Outcomes

Stuart N. Hoffman, DO,* John A. TenBrook, Jr, MD,* Michael P. Wolf, MD,*
Stephen G. Pauker, MD, FACC,*† Deeb N. Salem, MD, FACC,*† John B. Wong, MD*
Boston, Massachusetts

J Am Coll Cardiol 2003;41:1293–304

- Comparing PTCA with CABG.
- A meta-analysis of 13 randomized trials
- 7,964 patients

META-ANALYSIS of 13 RCT CABG vs PCI Hoffman SN et al: JACC 2003

- PATIENTS:
  - 2/3 had 2VD (41% prox LAD disease) and **100% had normal LV function**
  - **Excluded patients (L main, severe/complex 3VD, occlusions, poor LV)**

	FREEDOM FROM	nos	% RD (95% CI) favouring CABG	p	NNT
5 yr RESULTS All trials PCI vs CABG	ALL DEATH	4714	1.9 (0.33-3.4)	0.02	53
	Cardiac Death	2649	2.0 (0.29-3.7)	0.02	51
	REINTERVENTION	4572	37 (31-44)	<0.001	3
	Repeat CABG	3660	22 (16-27)	<0.001	5
	Repeat PCI	3660	23 (16-30)	<0.001	4
	Death/MI/Revasc	276	31 (21-41)	<0.001	3
	Angina	4322	5.3 (-0.08 - 11)	0.09	-

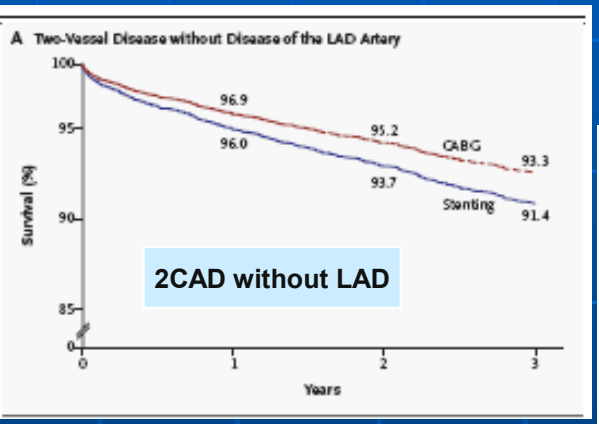
- **A small survival advantage (p=0.02, NNT=53)**
- **A marked reduction in the need for reintervention (p<0.001, NNT=4)**

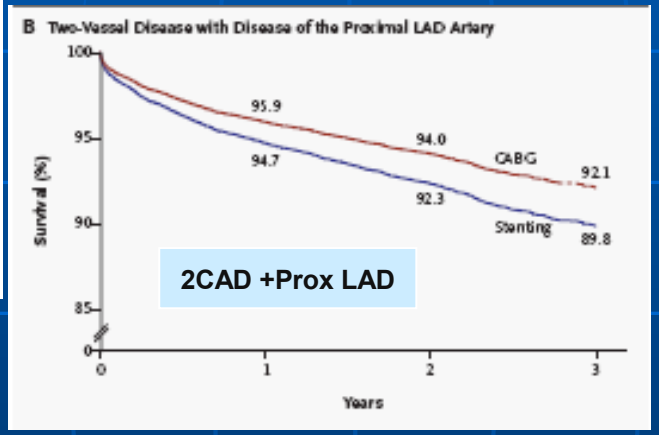
Long-Term Outcomes of Coronary-Artery Bypass Grafting versus Stent Implantation

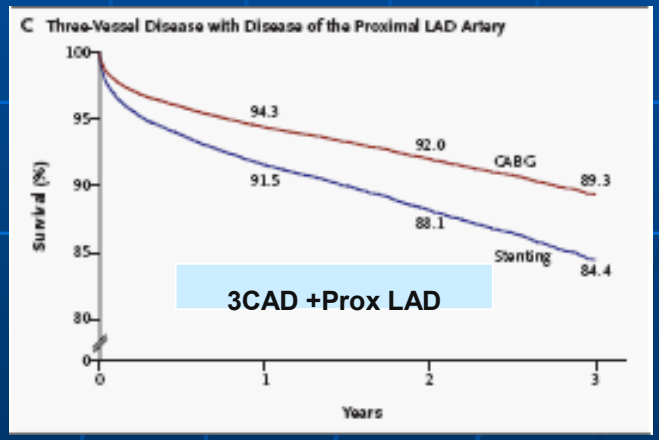
Edward L. Hannan, Ph.D., Michael J. Racz, Ph.D., Gary Walford, M.D., Robert H. Jones, M.D., Thomas J. Ryan, M.D., Edward Bennett, M.D., Alfred T. Culliford, M.D., O. Wayne Isom, M.D., Jeffrey P. Gold, M.D., and Eric A. Rose, M.D.

Stenting (N=22,102) CABG (N=37,212)

: Adjusted Survival Curves







CONCLUSIONS

For patients with two or more diseased coronary arteries, CABG is associated with higher adjusted rates of long-term survival than stenting.

N Engl J Med 2005;352:2174-83

Drug-Eluting Stents vs. Coronary-Artery Bypass Grafting in Multivessel Coronary Disease

Edward L. Hannan, Ph.D., Chuntao Wu, M.D., Ph.D., Gary Walford, M.D., Alfred T. Culliford, M.D., Jeffrey P. Gold, M.D., Craig R. Smith, M.D., Robert S.D. Higgins, M.D., Russell E. Carlson, M.D., and Robert H. Jones, M.D.

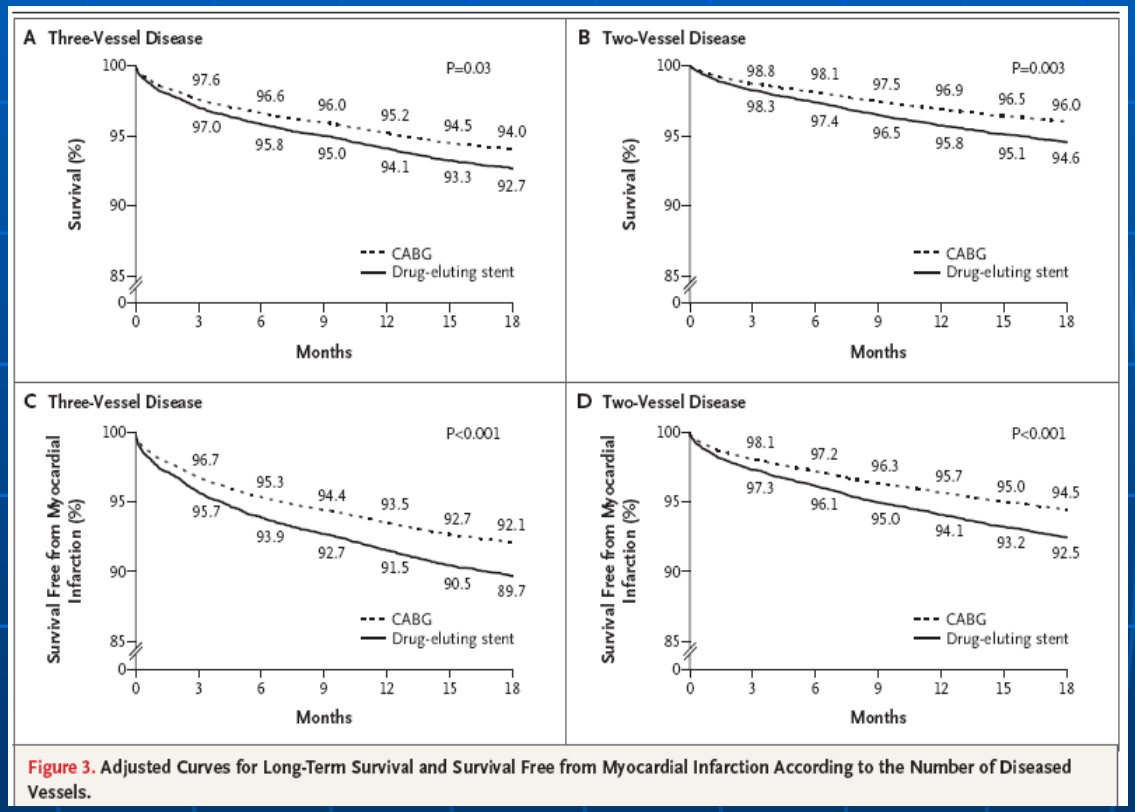


Figure 3. Adjusted Curves for Long-Term Survival and Survival Free from Myocardial Infarction According to the Number of Diseased Vessels.

Multivessel disease
DES(N = 9963)
CABG(N = 7437)
in New York State

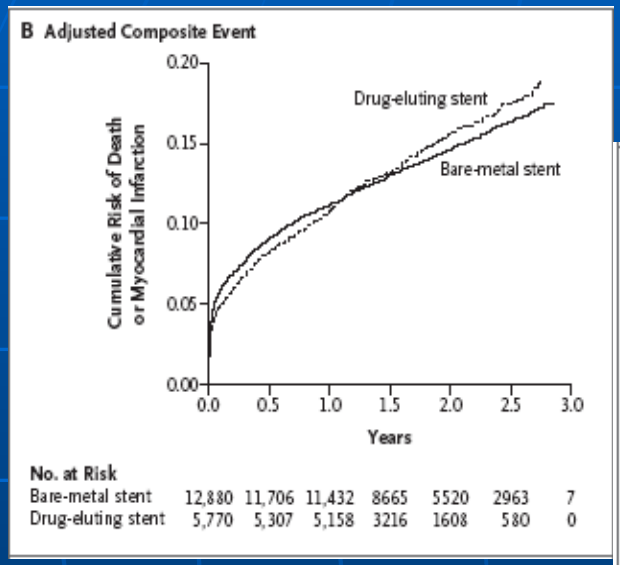
CABG is associated with lower rates of death or MI and repeat revascularization for 2 and 3 vessel disease

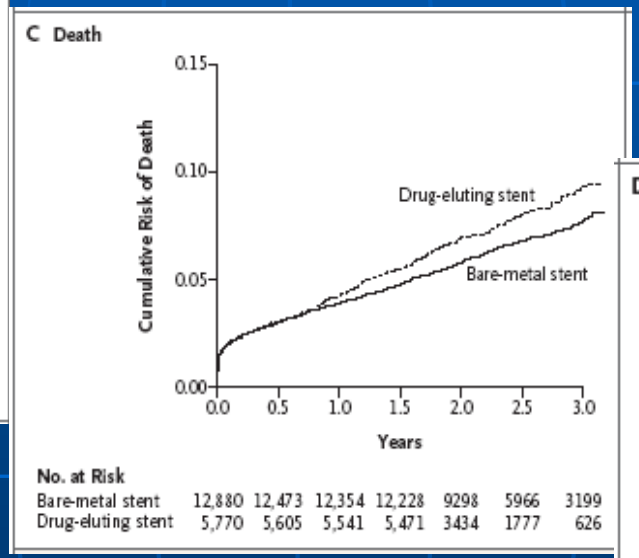
N Engl J Med 2008;358:331-41.

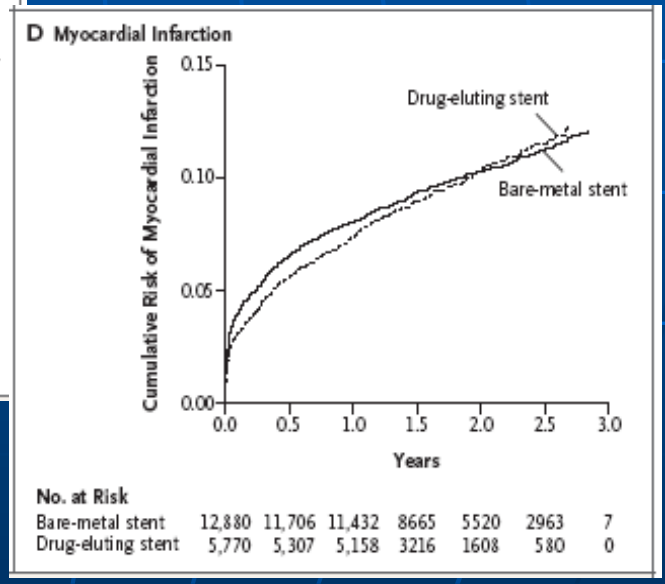
Long-Term Outcomes with Drug-Eluting Stents versus Bare-Metal Stents in Sweden

SCAAR DATA

6033 pt's treated with DES
13,738 pt's treated with BMS







DES were associated with increased rate of death, as compared with BMS after six months

.N Engl J Med 2007;356:1009-19

Medical treatment

ACC/AHA 2002 Guideline Update for the Management of Patients With Chronic Stable Angina

IV. TREATMENT

A. Pharmacologic Therapy

Recommendations for Pharmacotherapy to Prevent MI and Death and to Reduce Symptoms

Class I

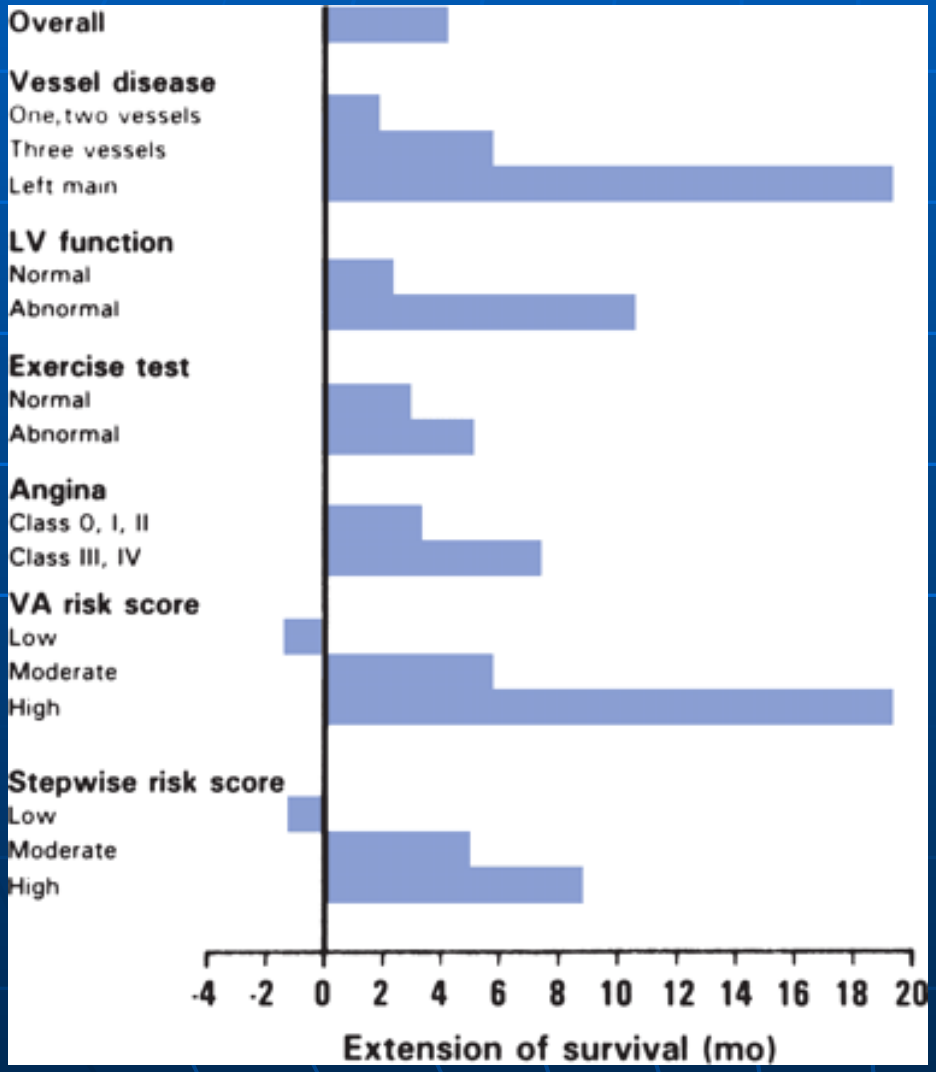
1. Aspirin in the absence of contraindications. *(Level of Evidence: A)*
2. Beta-blockers as initial therapy in the absence of contraindications in patients with prior MI *(Level of Evidence: A)* or without prior MI. *(Level of Evidence: B)*
3. Angiotensin converting enzyme inhibitor in all patients with CAD* who also have diabetes and/or LV systolic dysfunction. *(Level of Evidence: A)*
4. Low-density lipoprotein–lowering therapy in patients with documented or suspected CAD and LDL cholesterol greater than 130 mg per dl, with a target LDL of less than 100 mg per dl. *(Level of Evidence: A)*
5. Sublingual nitroglycerin or nitroglycerin spray for the immediate relief of angina. *(Level of Evidence: B)*
6. Calcium antagonists† or long-acting nitrates as initial therapy for reduction of symptoms when beta-blockers are contraindicated. *(Level of Evidence: B)*
7. Calcium antagonists† or long-acting nitrates in combination with beta-blockers when initial treatment with beta-blockers is not successful. *(Level of Evidence: B)*
8. Calcium antagonists† and long-acting nitrates as a substitute for beta-blockers if initial treatment with beta-blockers leads to unacceptable side effects. *(Level of Evidence: C)*

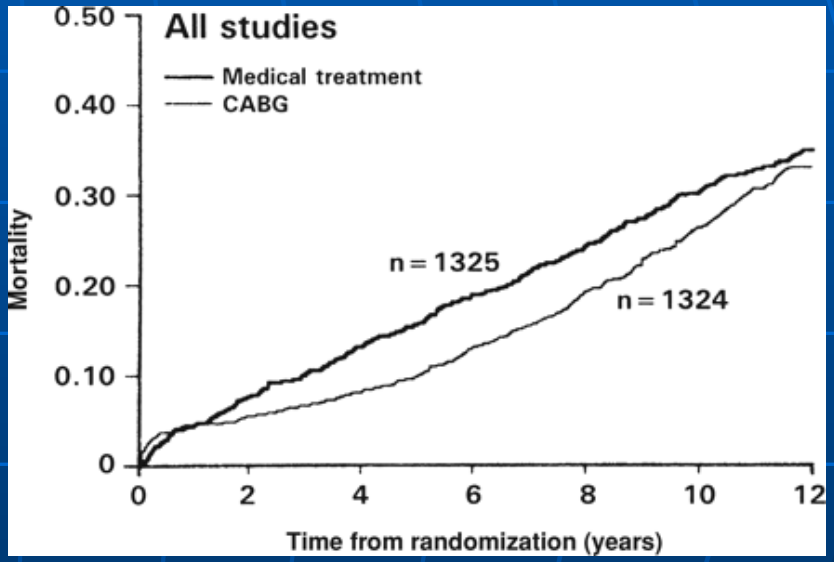
A = Aspirin and antianginal therapy
B = Beta blocker and blood pressure
C = Cigarette smoking and cholesterol
D = Diet and diabetes
E = Education and exercise

Surgical versus Medical Therapy

- Major randomized studies (1972 - 1984) :
  - The Coronary Artery Surgery Study (CASS)
  - The Veterans Administration Cooperative Study Group (VA)
  - The European Coronary Surgery Study (ECSS)

Survival (mortality) curves for all medically and surgically treated patients with chronic stable angina enrolled in seven prospective, randomized, controlled trials.

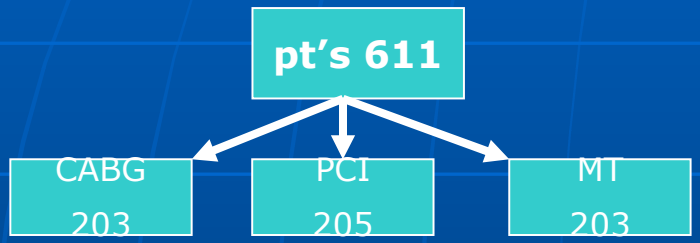


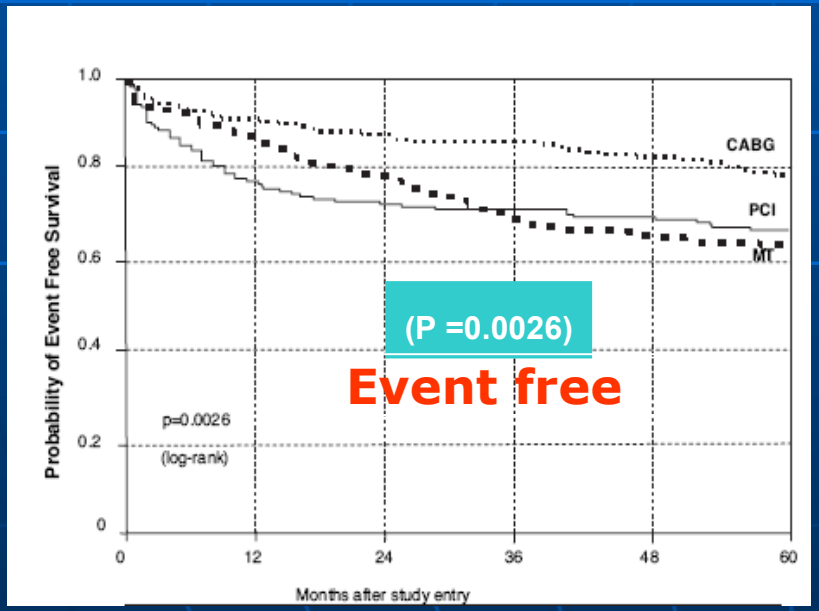


Lancet 1994; 344:563

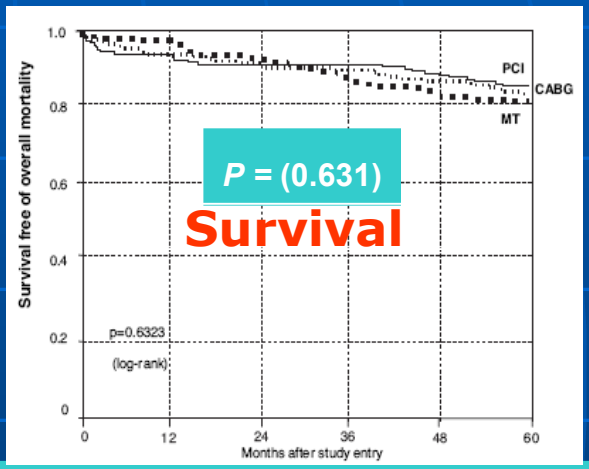
Five-Year Follow-Up of the Medicine, Angioplasty, or Surgery Study (MASS II)

A Randomized Controlled Clinical Trial of 3 Therapeutic Strategies for Multivessel Coronary Artery Disease





Probability of survival free of overall mortality



Conclusions :

- **Long-term events and rate of additional revascularization MT similar to PCI.**
- **CABG was superior to MT in terms of the primary end points, reaching a significant 44% reduction**

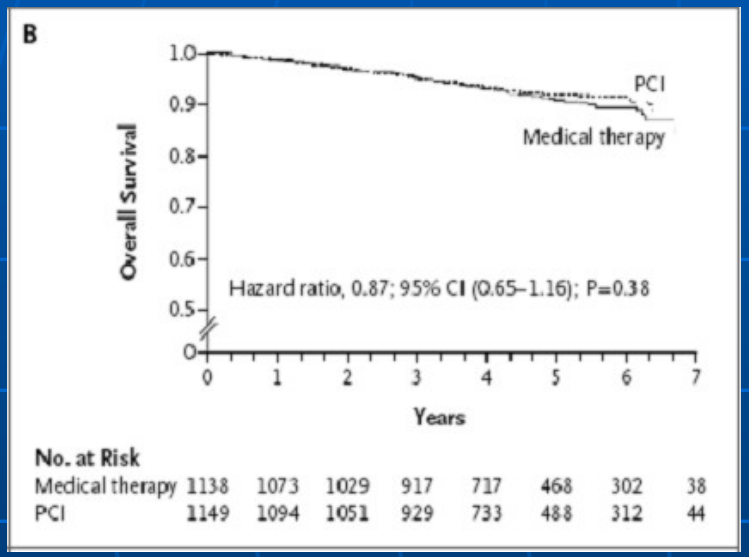
The primary end points were total mortality, Q-wave myocardial infarction, or refractory angina requiring revascularization.

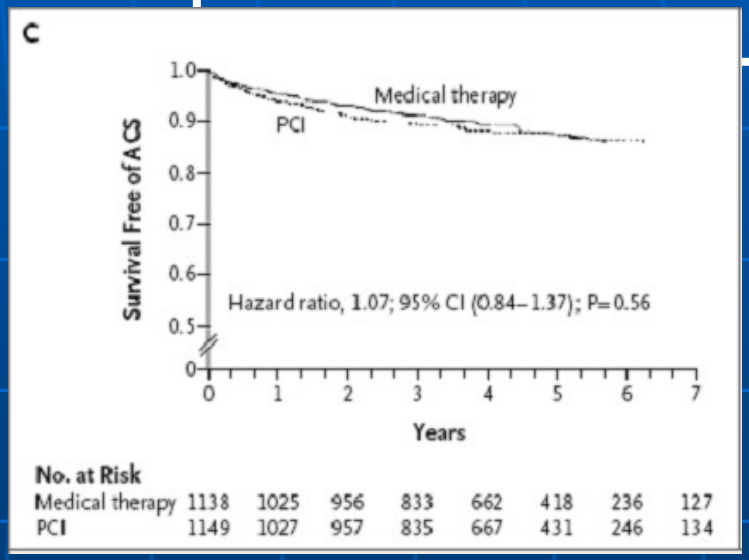
Circulation. 2007;115:1082-1089

Optimal Medical Therapy with or without PCI for Stable Coronary Disease

Clinical **O**utcomes **U**tilizing **R**evascularization and **A**ggressive Dru**g** **E**valuation **(COURAGE)** trial

- Randomized trial
- 2287 pt's
- F/U median- 4.6yr





CONCLUSIONS

As an initial management strategy in patients with stable coronary artery disease, PCI did not reduce the risk of death, myocardial infarction, or other major cardiovascular events when added to optimal medical therapy. (ClinicalTrials.gov number,

(COURAGE) N Engl J Med 2007;356.

A Meta-Analysis of 17 Randomized Trials of a Percutaneous Coronary Intervention-Based Strategy in Patients With Stable Coronary Artery Disease

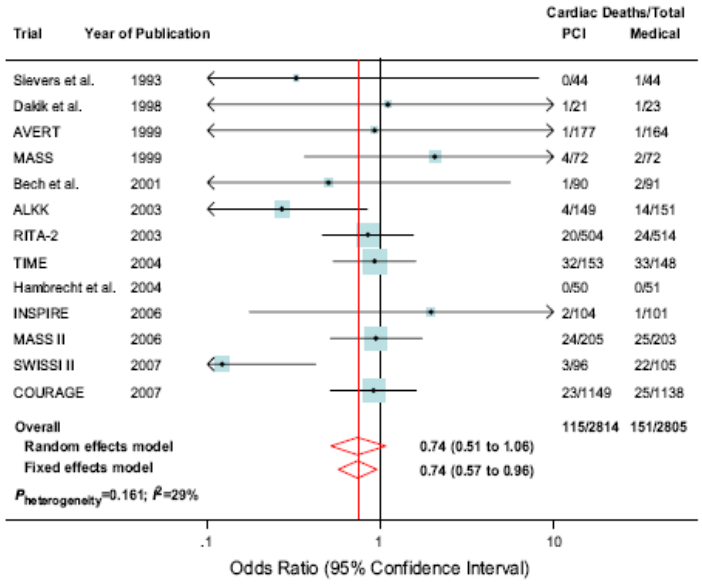


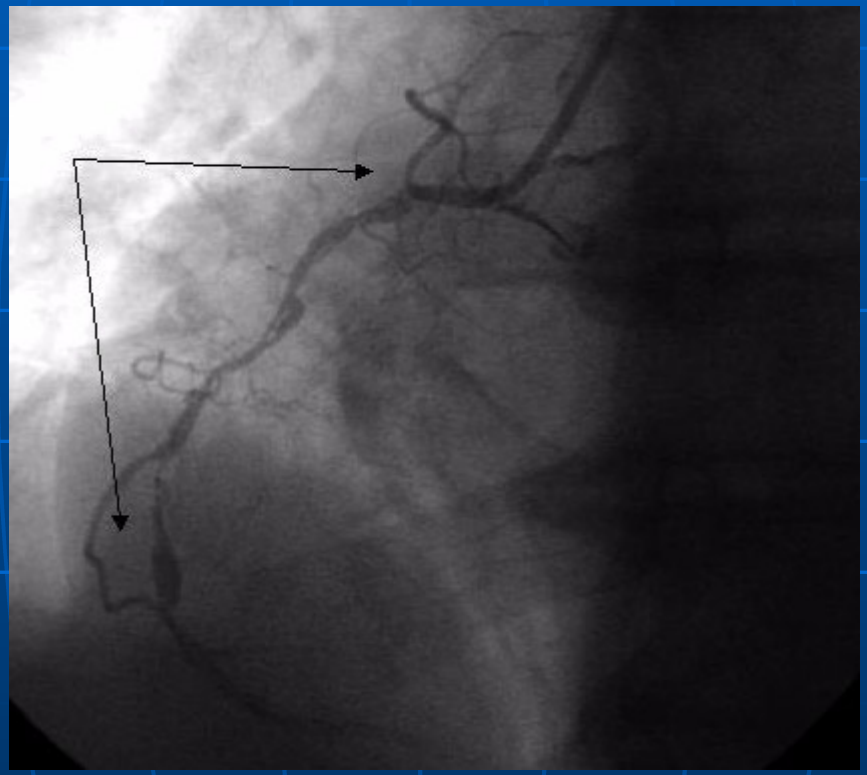
Figure 5 Odds Ratios for Cardiac Death in Individual Trials Comparing the PCI-Based Strategy With Medical Treatment Strategy

3,675 - PCI
3,838 – medical

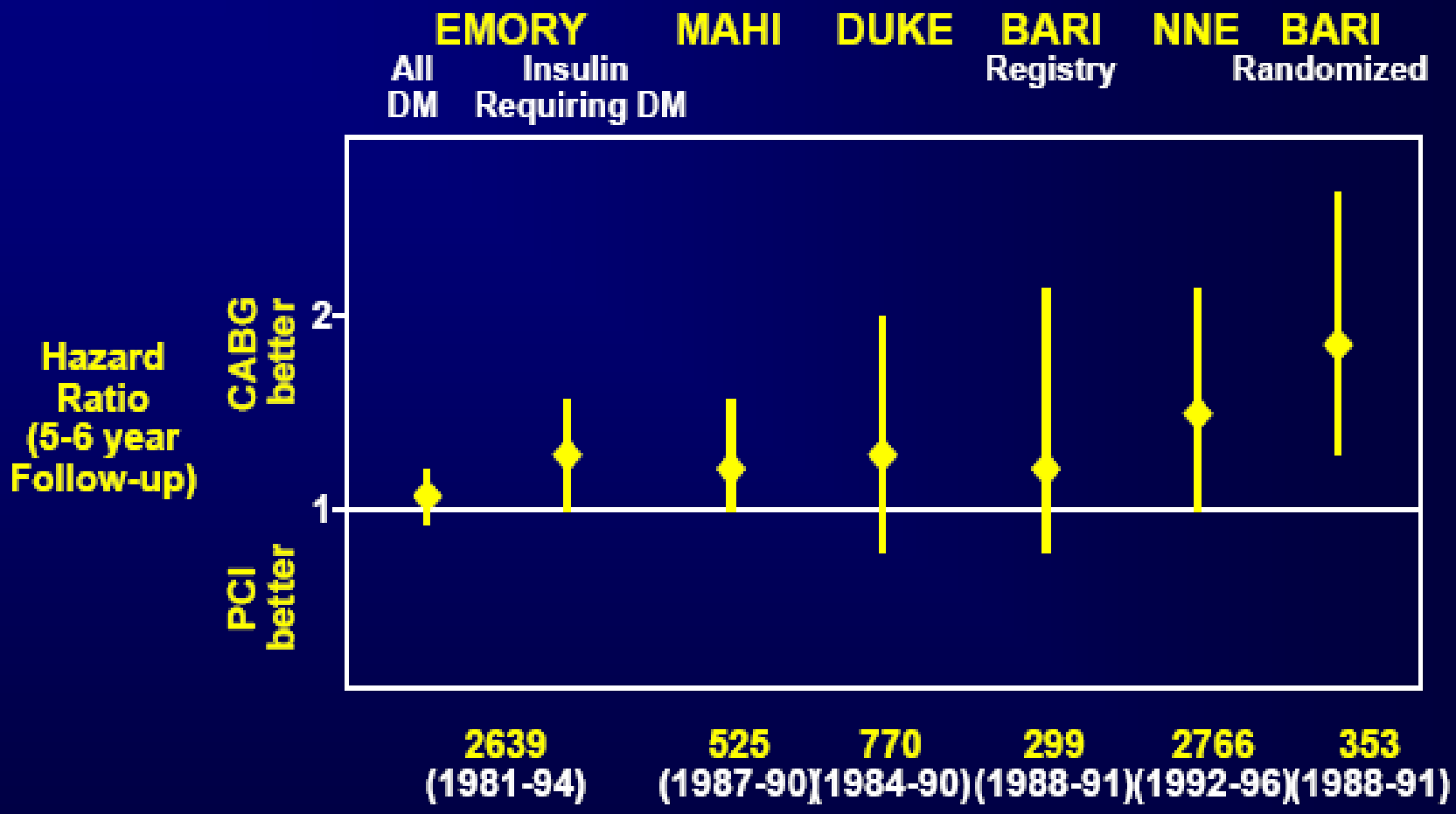
Conclusions These findings suggest that a PCI-based invasive strategy may improve long-term survival compared with a medical treatment-only strategy in patients with stable coronary artery disease. (J Am Coll Cardiol 2008;52:894–904) © 2008 by the American College of Cardiology Foundation

J Am Coll Cardiol 2008;52:894–904

Diabetes Mellitus



DIABETIC SURVIVAL - PCI vs CABG

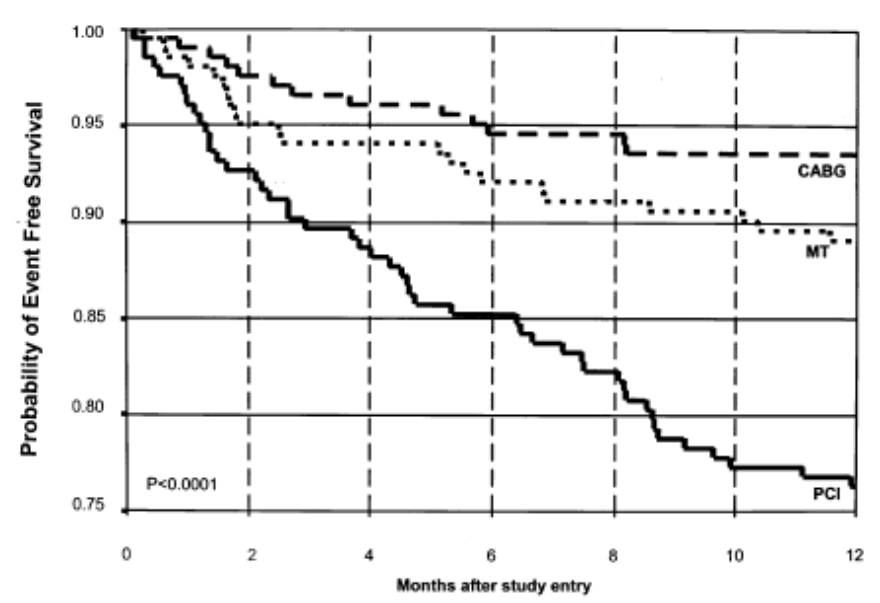


NNE (NW Niles et al.) JACC 2001; 37:1008

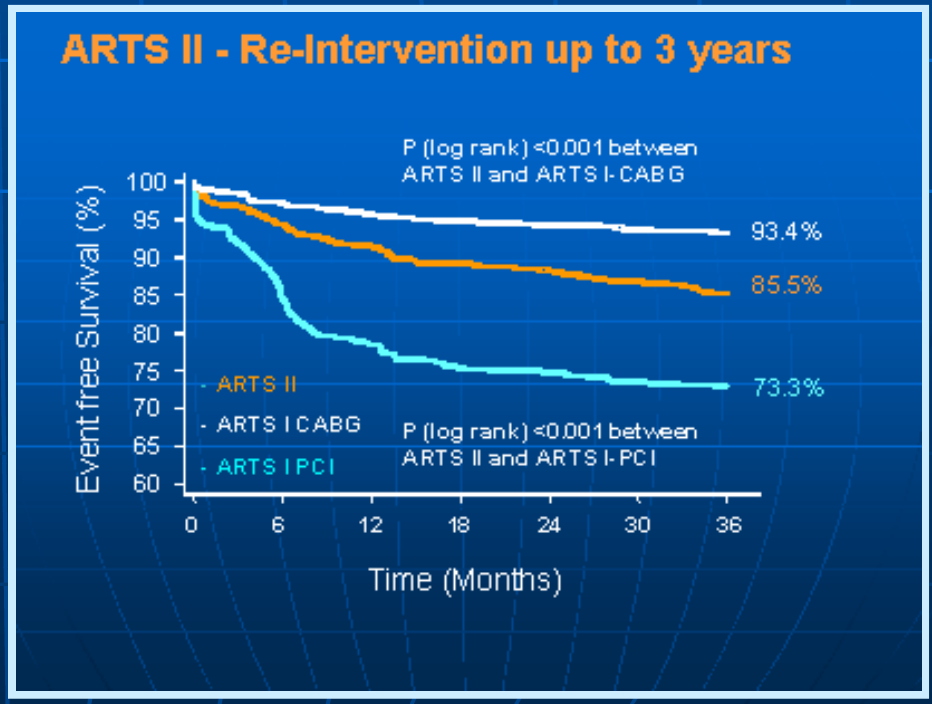
MASS STUDY

CORONARY ARTERY DISAESE AND DIABETES MELLITTUS

Free survival of Severe Cardiac Events
Diabetics

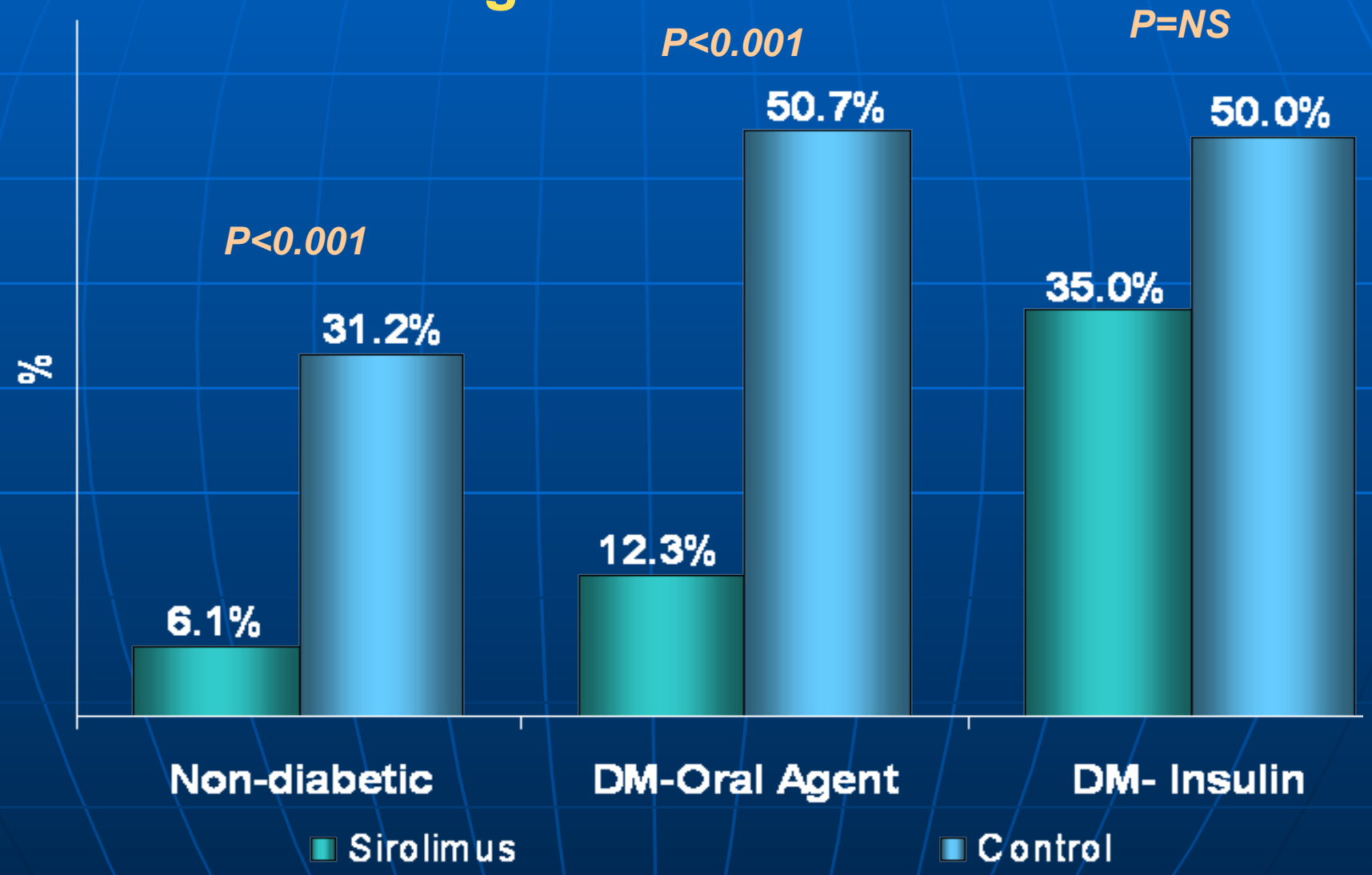


JACC Vol. 43, No. 10, 2004
May 19, 2004:1743–51



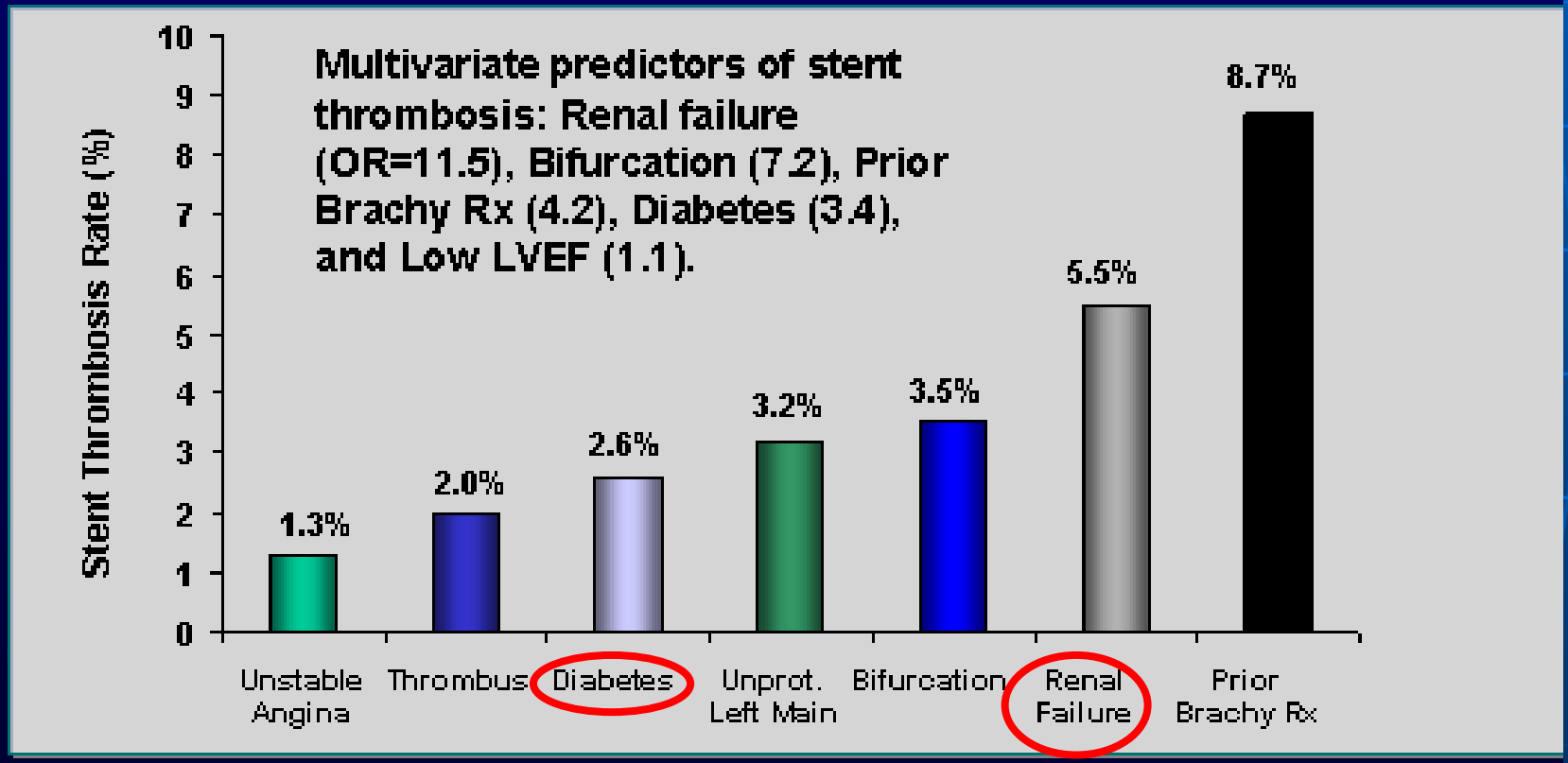
SIRIUS – Reduced Efficacy in IDDM

In-Segment Restenosis



Incidence of Stent thrombosis after DES

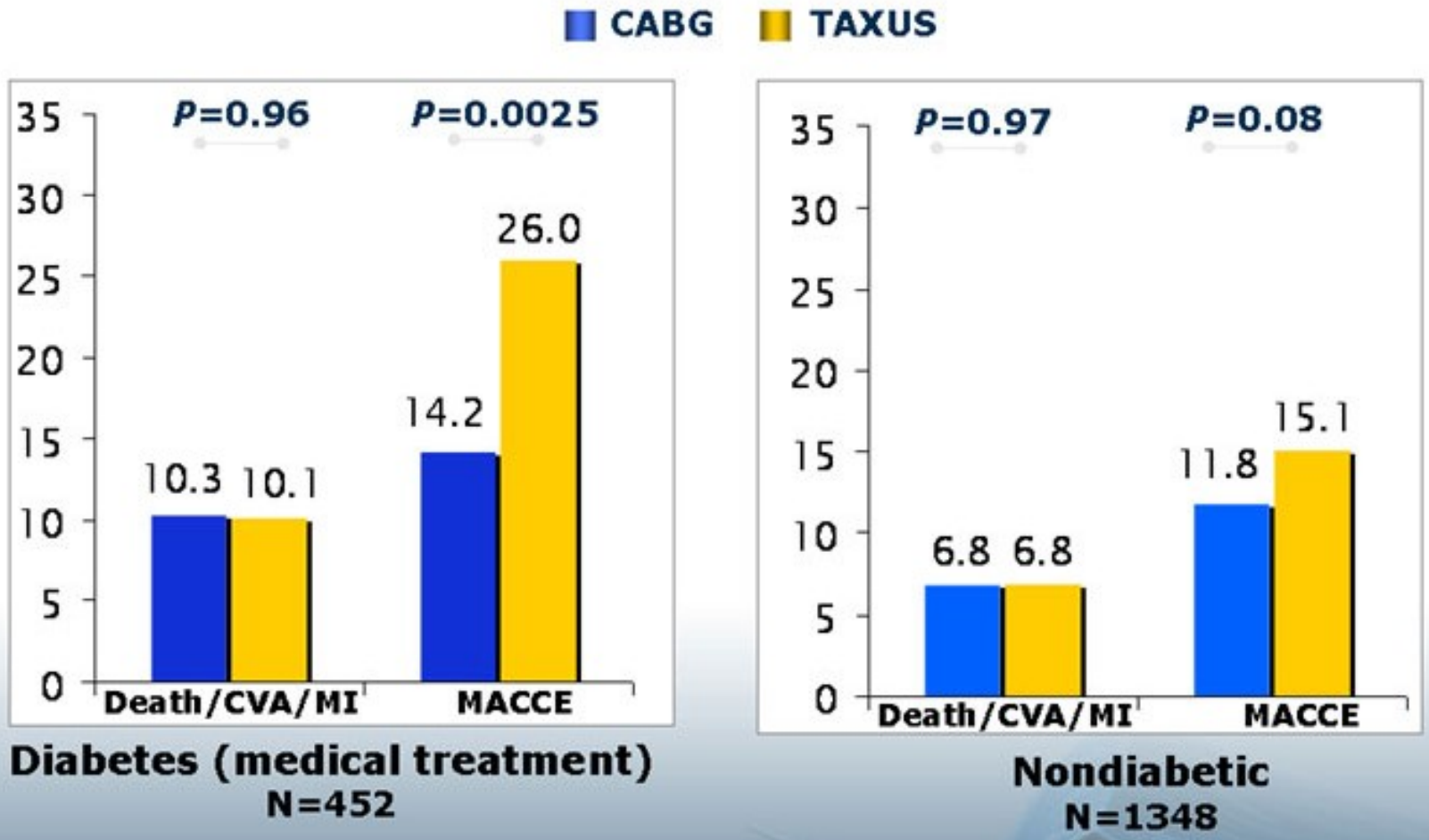
2229 consecutive with successful DES implantation
ASA indefinitely; Plavix or Ticlid ≥3 months (SRL) and ≥6 months (PXL)



Iakovou I et al. JAMA 2005;293:2126-2130

DHHS/FDA

Outcome According to Diabetic Status

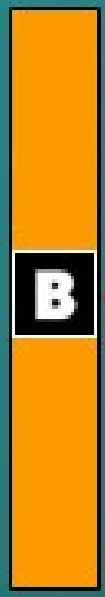


Serruys P, et al. ESC 2008.

CRF DES Evidence-based Medicine

Guidelines Summary

2007



- Routine bifurcation dual DES (T, SKS (V), culotte or crush of sidebranch)
- Ultra-long lesions (full metal jacket)
- Unprotected left main
- Multivessel disease (complex and diffuse, esp DM)
- Acute myocardial infarction
- ISR after failed brachy (if no surgical option!)

"Large, multicenter trials are underway (FREEDOM, SYNTAX, HORIZONS) which will provide critical evidence-based guidance to the appropriate use of DES in many of these off-label conditions"

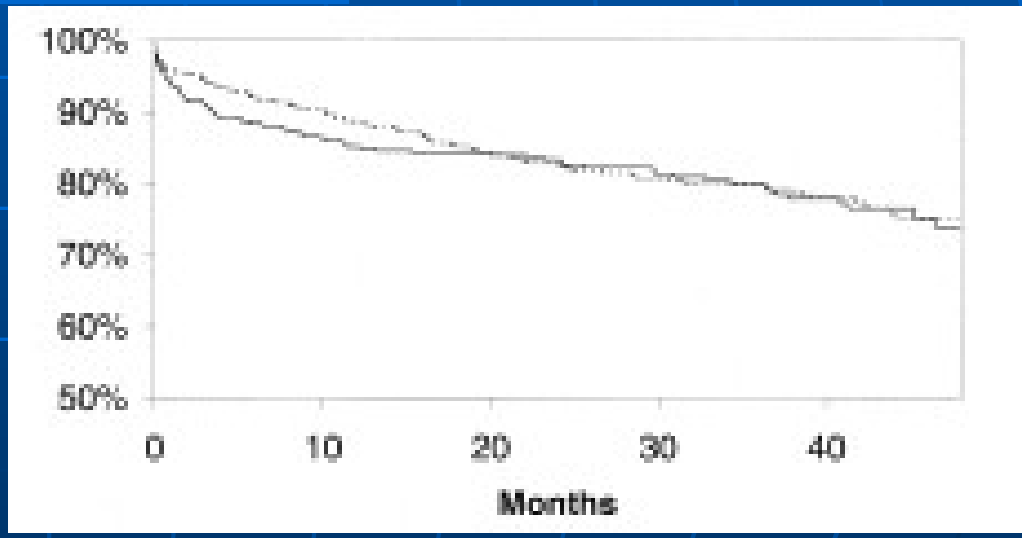
Diabetes and Outcomes of Coronary Artery Bypass Graft Surgery in Patients With Severe Left Ventricular Dysfunction: Results from The CABG Patch Trial Database

William Whang, MD, MS, J. Thomas Bigger, Jr., MD, FACC, for The CABG Patch Trial Investigators and Coordinators

New York, New York

J Am Coll Cardiol 2000;36:1166–72

- Diabetes **was not** a predictor of mortality after CABG surgery among patients with LV dysfunction despite associated comorbidities.
- Diabetes was associated with increased postoperative complications and re-hospitalization.



JACC
Journal of the American College of Cardiology

Drug-Eluting Stents Versus Coronary Artery Bypass Grafting in Patients with Diabetes Mellitus

Yanai Ben-Gal, MD, Yaron Moshkovitz, MD, Nachum Nesher, MD, Gideon Uretzky, MD, Rony Braunstein, PhD, Alberto Hendler, MD, Einat Zivi, BmedSc, Itzhak Herz, MD, and Rephael Mohr, MD

Ann Thorac Surg 2006;82:1692–7

518 consecutive diabetic patients

by PCI 176 Cypher

treated 342 surgically

Angina free survival

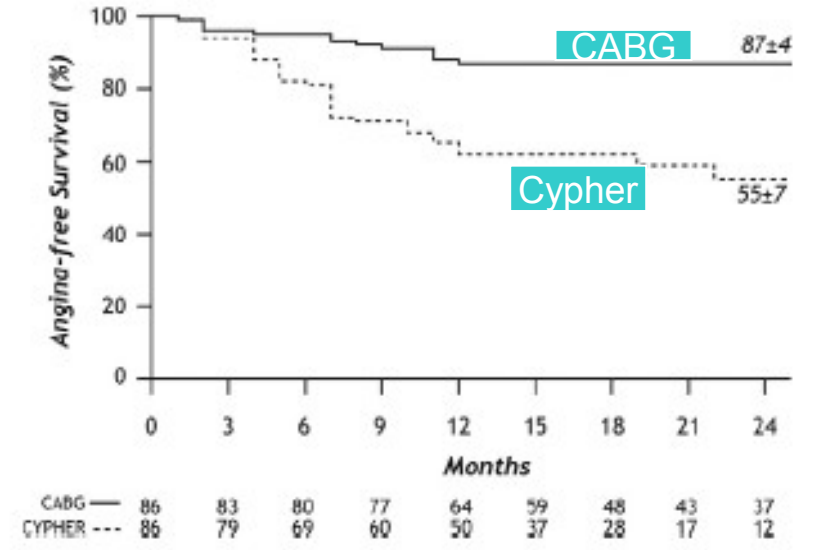
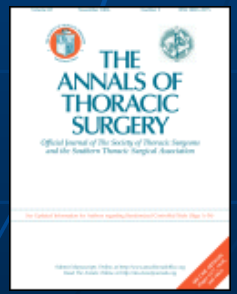


Fig 1. Angina-free survival of Cypher versus coronary artery bypass grafting (CABG) groups (p = 0.0001, log-rank test).

Coronary Disease	CABG (n = 86)	Cypher (n = 86)	p
Left Main	13 (15.1%)	2 (2.3%)	0.003
Three-vessel treated[a]	27 (31.4%)	9 (10.5%)	0.001
Ejection fraction <0.30	10 (11.6%)	0 (0%)	0.001



Single Versus Bilateral Internal Mammary Artery for Isolated First Myocardial Revascularization in Multivessel Disease: Long-Term Clinical Results in Medically Treated Diabetic Patients

Antonio Maria Calafiore, MD, Michele Di Mauro, MD, Gabriele Di Giammarco, MD, Giovanni Teodori, MD, Angela Lorena Iacò, MD, Valerio Mazzei, MD, Giuseppe Vitolla, MD, and Marco Contini, MD

Division of Cardiac Surgery, University Hospital, Torino, Division of Cardiac Surgery, "G D'Annunzio" University, Chieti, and Division of Cardiac Surgery, Papardo Hospital, Messina, Italy

Table 3. Postoperative Results

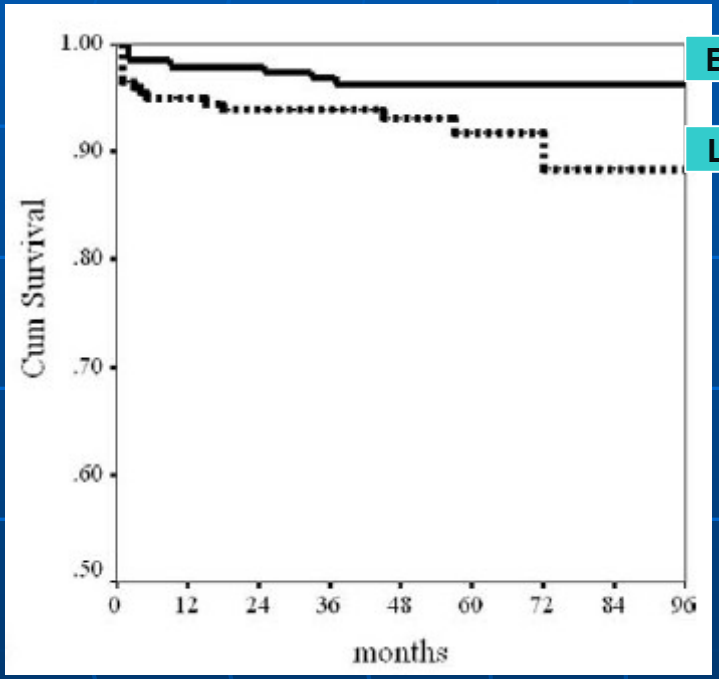
	BIMA Group n = 200	LIMA Group n = 200	*p* Value
Deaths	6 (3.0)	10 (5.0)	0.307
Cardiac deaths	0	7 (3.5)	0.015
Acute myocardial infarction	1 (0.5)	5 (2.5)	0.215
Cerebrovascular accident	4 (2.0)	2 (1.0)	0.685
Early negative primary endpoints	8 (4.0)	12 (6.0)	0.358
Early major events	14 (7.0)	24 (12.0)	0.088
Sternal wound problems	6 (3.0)	3 (1.5)	0.500

- **Pedicled IMA harvesting** was related to a **higher incidence** of sternal complications, both in the LIMA and in the BIMA group

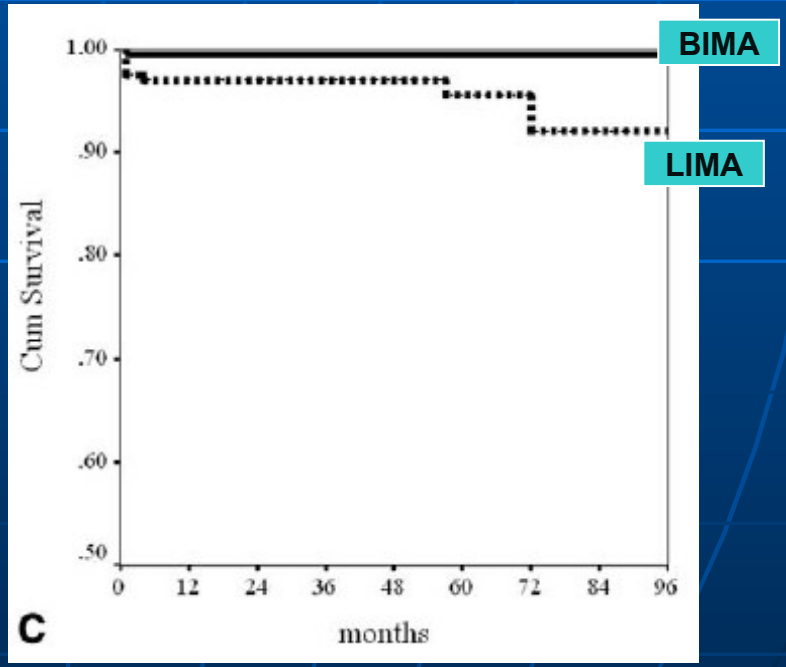
Ann Thorac Surg 2005;80:888 –95

: Eight-Year Actuarial Results

year freedom from cardiac death-8

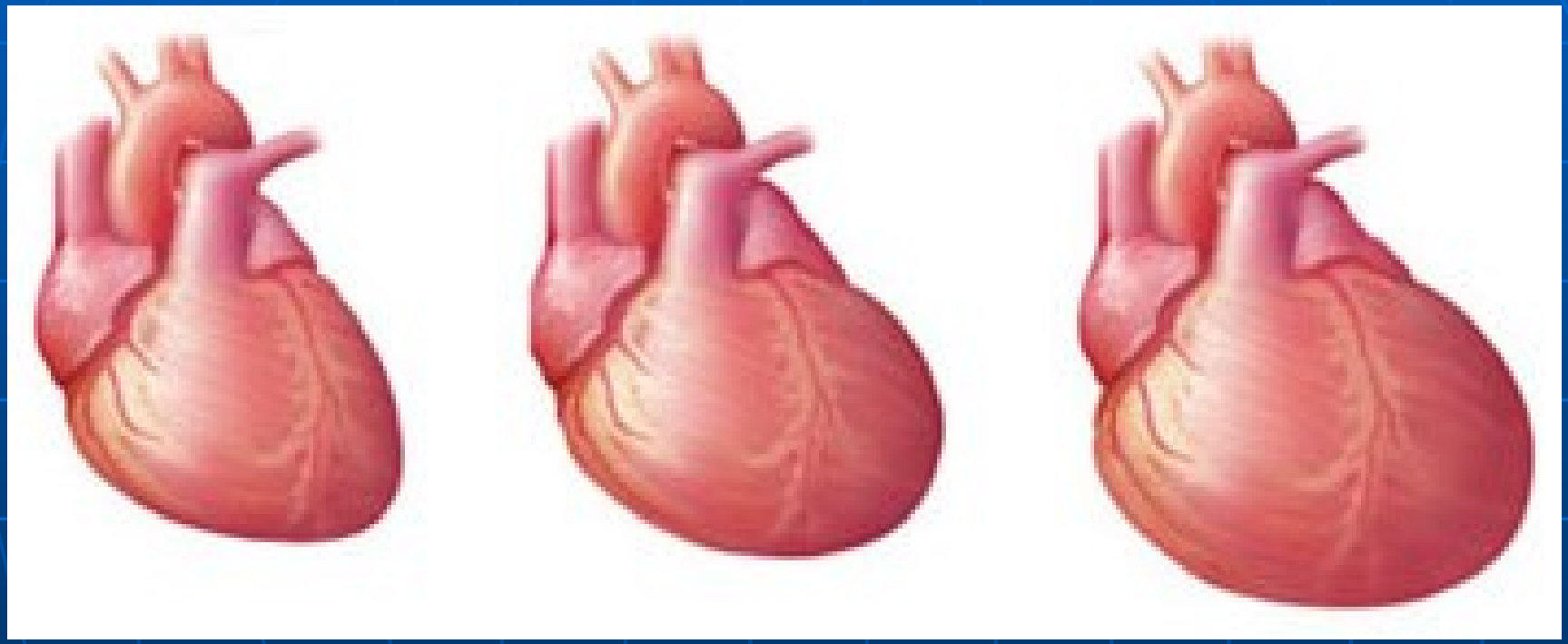


year freedom from acute MI-8



Ann Thorac Surg
2005;80:888–95

LV Dysfunction



Myocardial Revascularization

- Seems to be beneficial when more then 25% viability is present

- Metanalysis *(Allman et al. J Am Coll Cardiol 2002;39:1151-8)*
  - 3088 patients
  - LVEF 32±8%
  - Follow-up 25±10 months

	Annual mortality	
	+VIABILITY	-VIABILITY
CABG	3.2%	7.7%
Medical	16%	6.2%

Poor LV

Class III

1. CABG should not be performed in patients with poor LV function without evidence of intermittent ischemia and without evidence of significant revascularizable viable myocardium. (*Level of Evidence: B*)

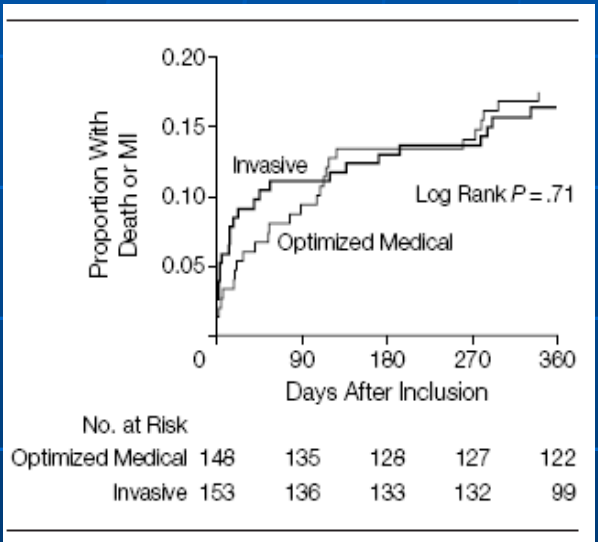
יש לי תור לניתוחי "חזה"...

Outcome of Elderly Patients With Chronic Symptomatic Coronary Artery Disease With an Invasive vs Optimized Medical Treatment Strategy

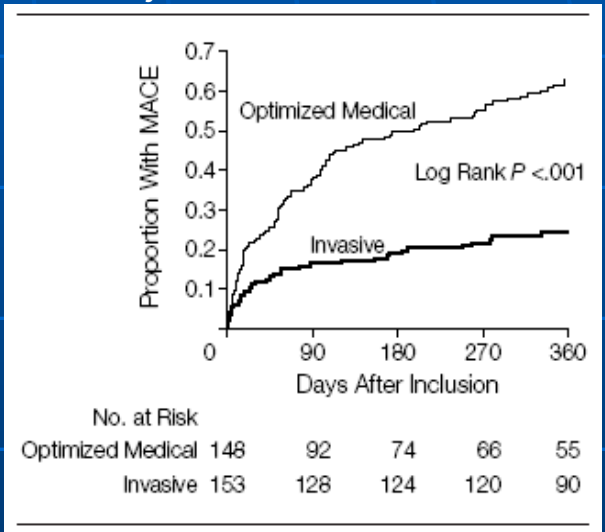
One-Year Results of the Randomized TIME Trial

- Prospective randomized trial
- **282 pt's** ;mean age- **80 yr**
- 14 centers in Switzerland

Time to Death or Nonfatal MI



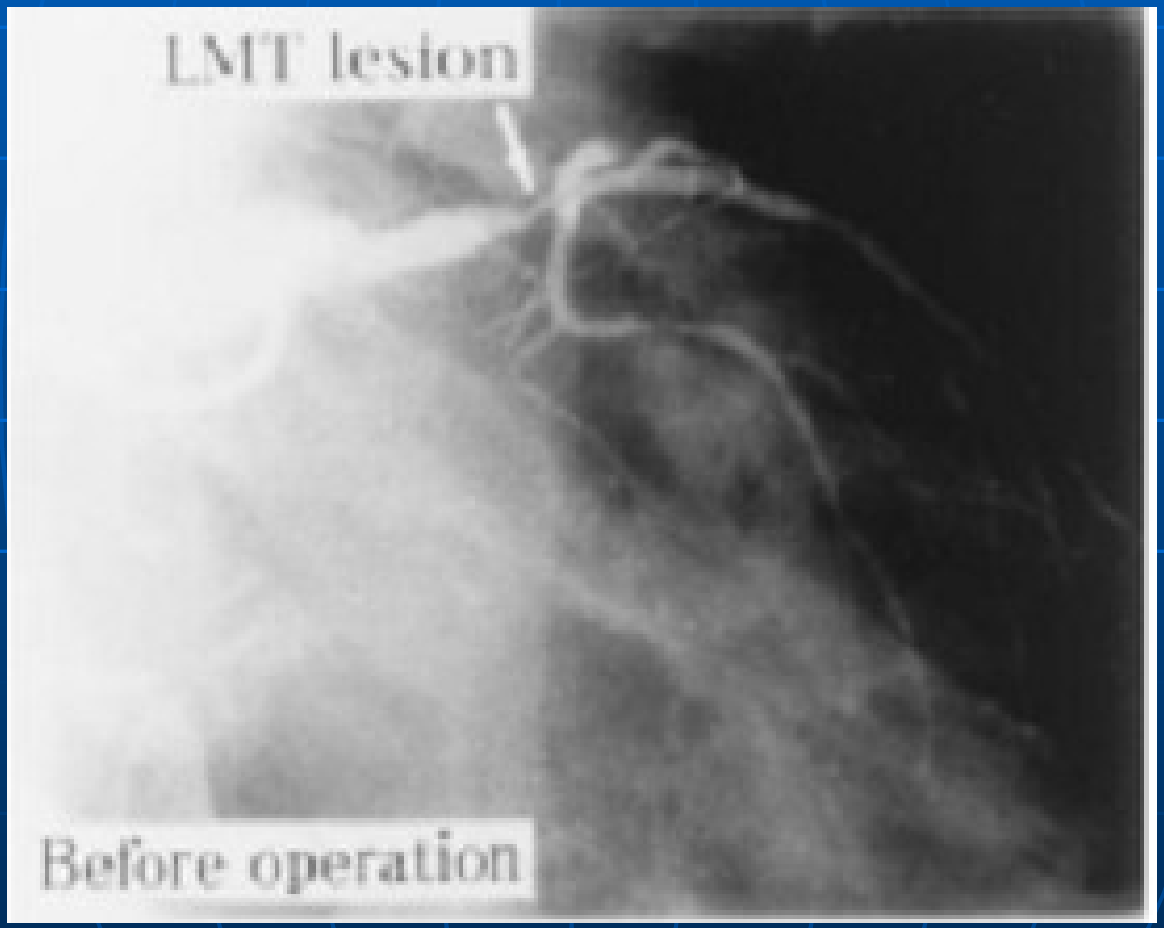
(Rates of Major Adverse Clinical Events (MACE

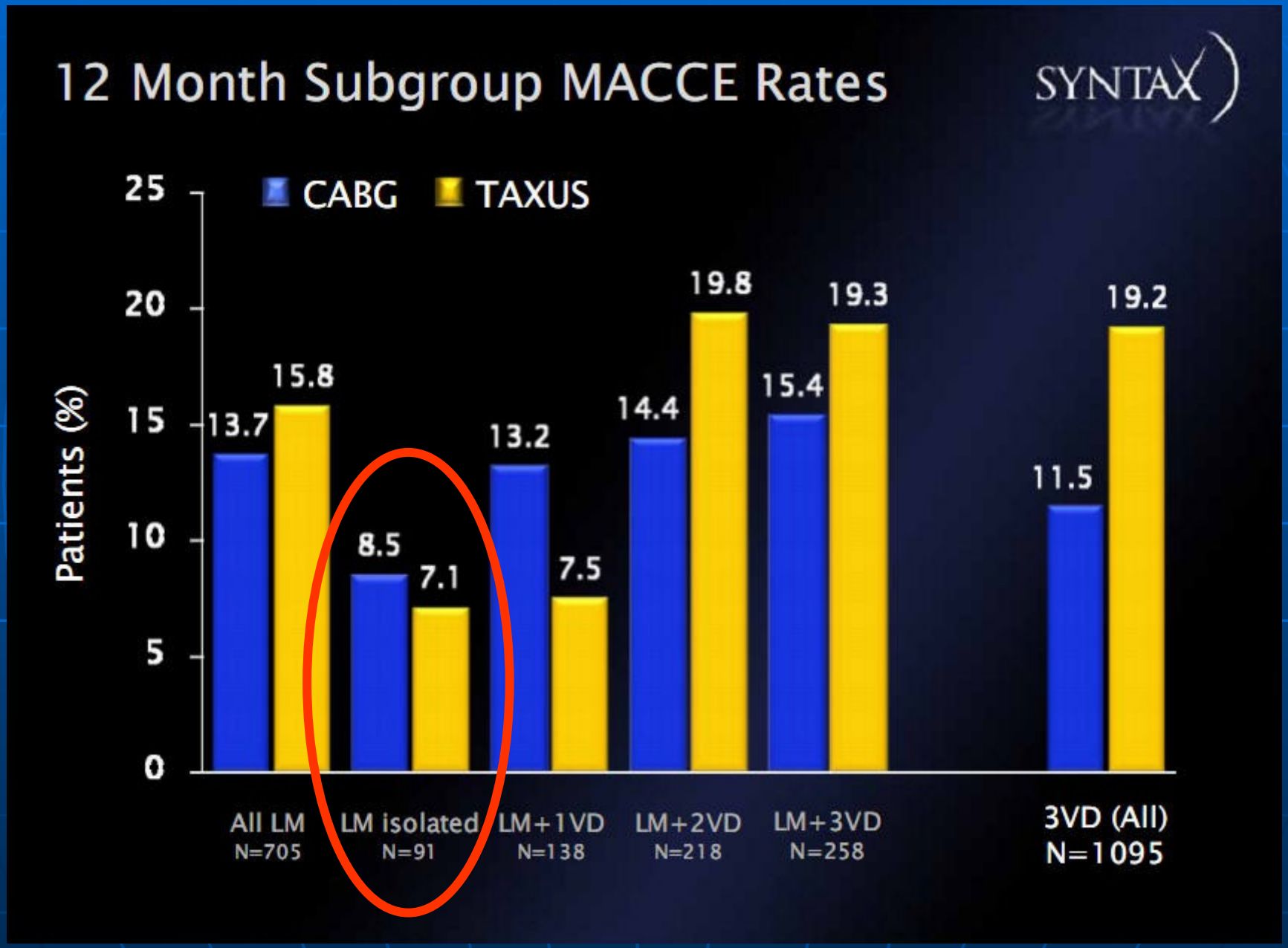


INV - symptom relief"cost" intervention
MT - 50%late nonfatal events

JAMA. 2003;289:1117-1123

Left Main Disease




12 Month Subgroup MACCE Rates
SYNTAX
CABG
TAXUS
Patients (%)
25
20
15
10
5
0
13.7
15.8
8.5
7.1
13.2
7.5
14.4
19.8
15.4
19.3
11.5
19.2
All LM
N=705
LM isolated
N=91
LM+1VD
N=138
LM+2VD
N=218
LM+3VD
N=258
3VD (All)
N=1095

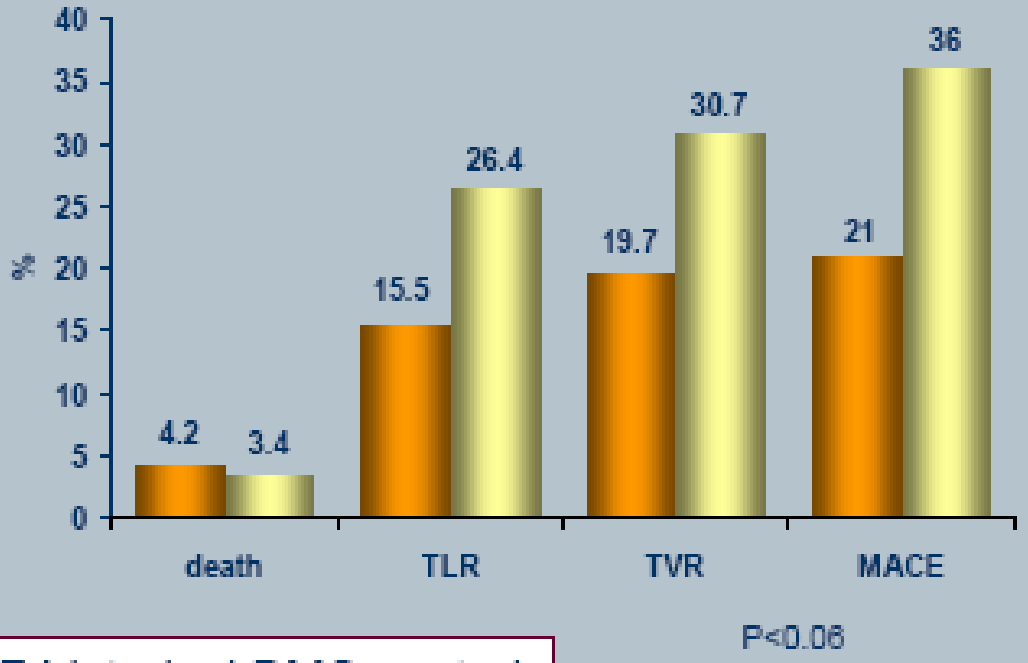
LEFT MAIN: Bare metal stenting (BMS) in 'suitable' vs CABG in ALL

				Hospital		1-2 year	
	Sites	Nos	stent	Mortality	Revasc	Mortality	Revasc
Keeley (Am J Cardiol 1999)	1	54	100%	5%	20%	31%	15%
Tan (Circ 2001): ALL	25	279	85%	14%	?	24%	34%
Tan (Circ 2001): LOW RISK	25	89	85%	3.4%	?	3.4%	31%
Takagi (Circ 2002)	1	63	58%	0%	10%	16%	31%
Park (Am J Cardiol 2003)	4	270	100%	0%	4%	7%	29%
Brueren (Heart 2003)	1	71	64%	1%	4%	10%	25%
Kelley (Eur H J 2003)	3	43	100%	9%	?	28%	20%
SUMMARY: 7 PCI trials	**35**	**780**	**88%**	**6%**	**4%**	**17%**	**29%**
CABG ONPUMP (2000-5)	**7**	**3293**		**3.4%**			
CABG OFFPUMP (2000-5)	**7**	**1225**		**1.1%**			

- **PCI**
  - **most studies do not specify what % of all LM were enrolled**
  - **presumably only 'suitable' lesions**
- **Even in anatomically favourable LM lesions with PCI there is**
  - **an immediate 6% mortality and 4% repeat revascularization.**
  - **at 1 yr overall 17% mortality and 29% require repeat revascularization**

DES in unprotected LMS
The Milan experience

Crush	59%
Culotte	9%
V	24%
T	8%



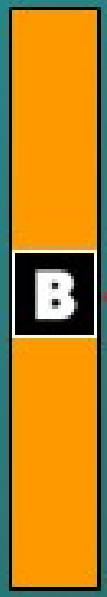
71 DES vs. 67 historical BMS control

TCT2004

Drug eluting stents (DES) vs BMS in Left Main

		Chieffo/Colombo Circ 2005		Valgimigli/Serruys Circ 2005	
		64 BMS	85DES	86 BMS	95 DES
30 day	% Mortality			7	11
	% Repeat Revascularization			2	0
	% MACE			19	15
6 months	% Mortality	9	**4**		
	% Repeat Revascularization	31	19		
	% MACE	36	**20**		
18 months	% Mortality			16	**14**
	% Repeat Revascularization			23	**6**
	% MACE			45	**24**

CRF DES Evidence-based Medicine Guidelines Summary 2007



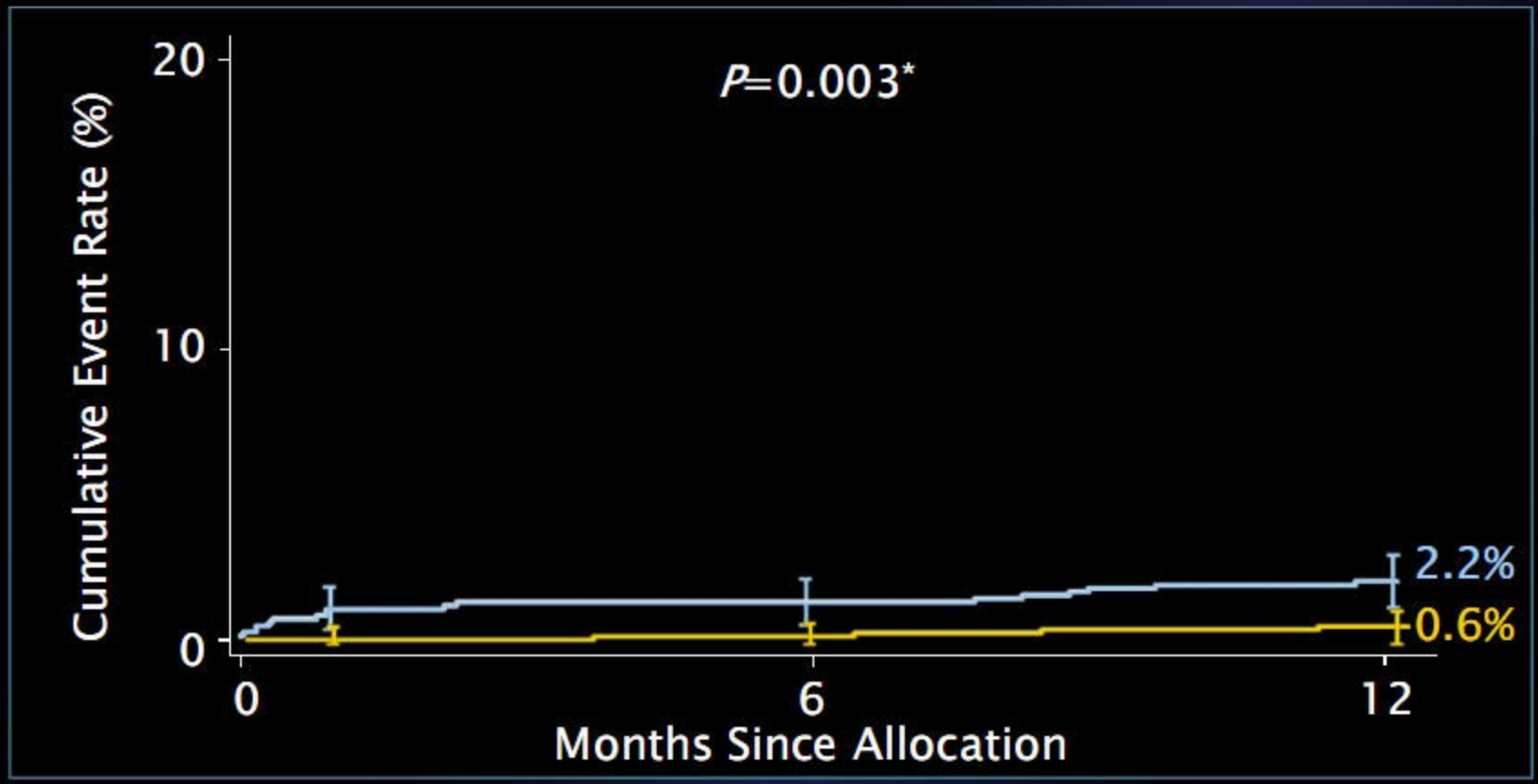
- Routine bifurcation dual DES (T, SKS (V), culotte or crush of sidebranch)
- Ultra-long lesions (full metal jacket)
- Unprotected left main
- Multivessel disease (complex and diffuse, esp DM)
- Acute myocardial infarction
- ISR after failed brachy (if no surgical option!)

"Large, multicenter trials are underway (FREEDOM, SYNTAX, HORIZONS) which will provide critical evidence-based guidance to the appropriate use of DES in many of these off-label conditions"

CVA

CVA to 12 Months

SYNTAX



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

ITT population

The Society of Thoracic Surgeons: 30-Day Operative Mortality and Morbidity Risk Models

A. Laurie W. Shroyer, PhD, Laura P. Coombs, PhD, Eric D. Peterson, MD, Mary C. Eiken, MSN, Elizabeth R. DeLong, PhD, Anita Chen, MS, T. Bruce Ferguson, Jr, MD, Frederick L. Grover, MD, and Fred H. Edwards, MD

Ann Thorac Surg 2003;75:1856-1865

STS

Table 2. CABG-Only Outcomes (1997–1999)

Outcome	Percentage for All CABG Records n = 503,478
30-day operative mortality	3.05
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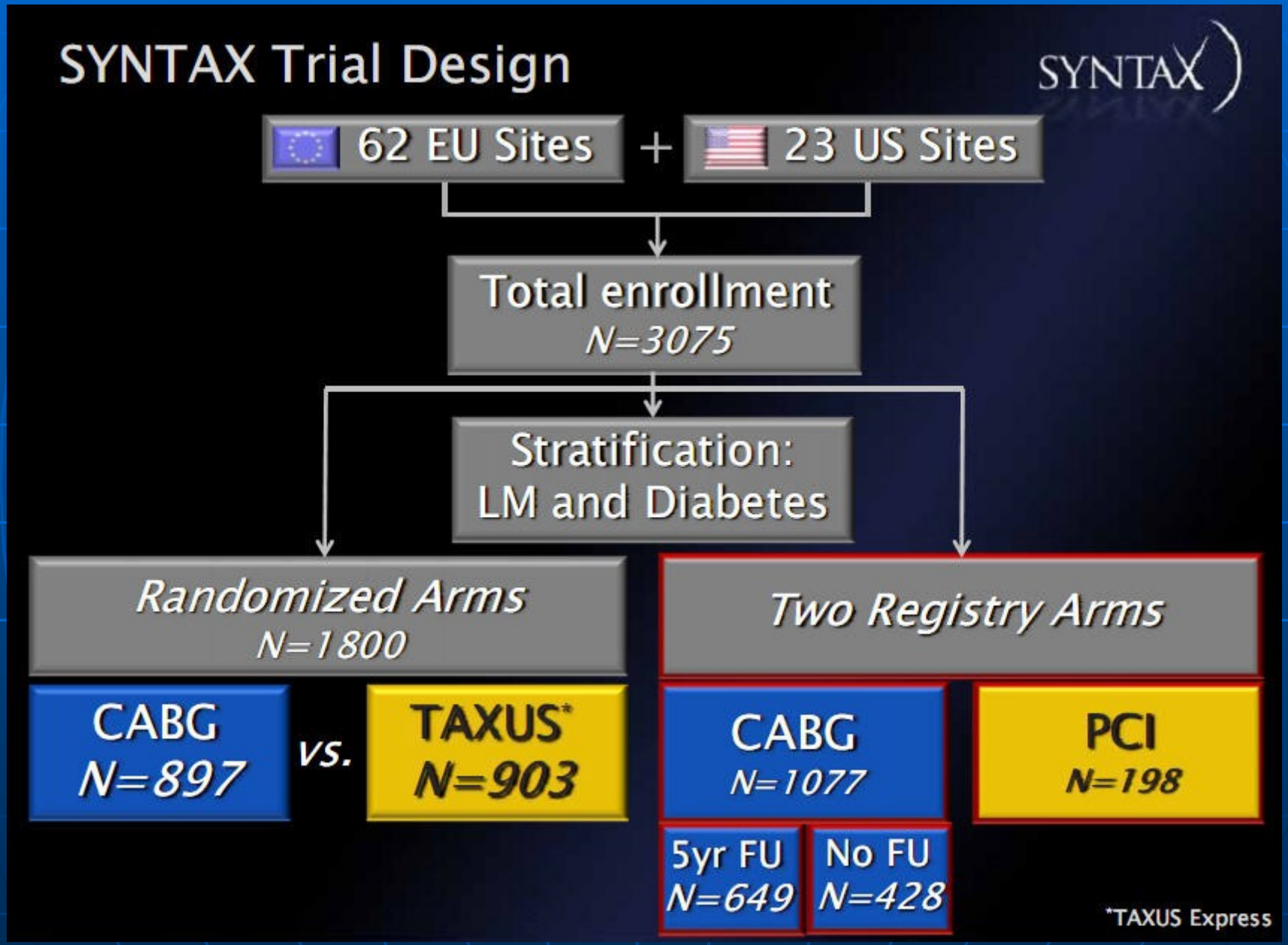
Prolonged ventilation	5.96
Deep sternal wound infection	0.63
Cardiac surgery reoperation	5.17
Composite major morbidity/mortality	13.40

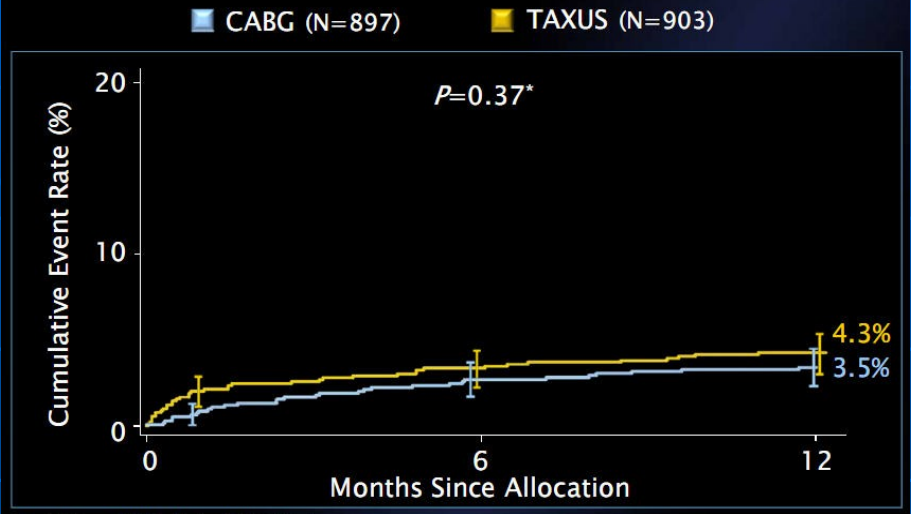
Number of records = 503,478 CABG-only records.

Surgeon's Perspective

- Time to procedure longer for CABG
- Only 30% CABG patients on preprocedure antiplatelet therapy vs almost all PCI on dual antiplatelet therapy


SYNTAX Trial Design
SYNTAX
62 EU Sites
+
23 US Sites
Total enrollment
N=3075
Stratification:
LM and Diabetes
Randomized Arms
N=1800
Two Registry Arms
CABG
N=897
vs.
TAXUS*
N=903
CABG
N=1077
PCI
N=198
5yr FU
N=649
No FU
N=428
*TAXUS Express

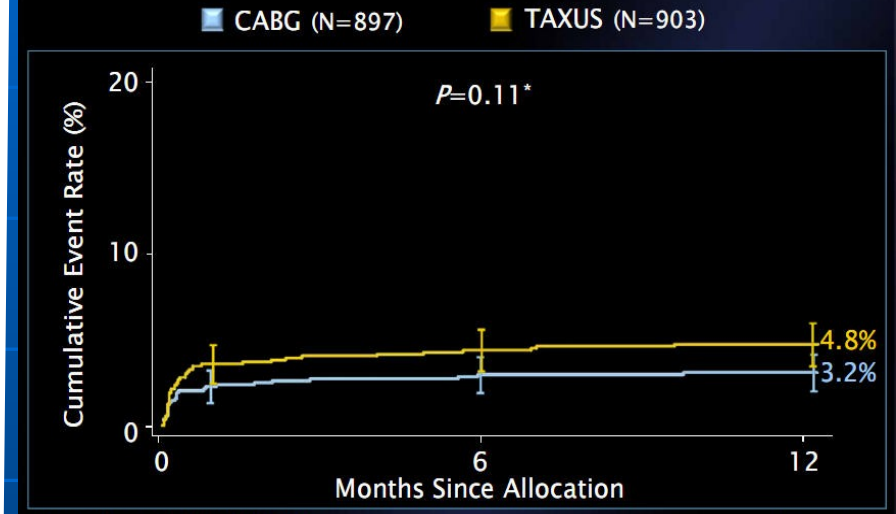
All-Cause Death to 12 Months



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

ITT population

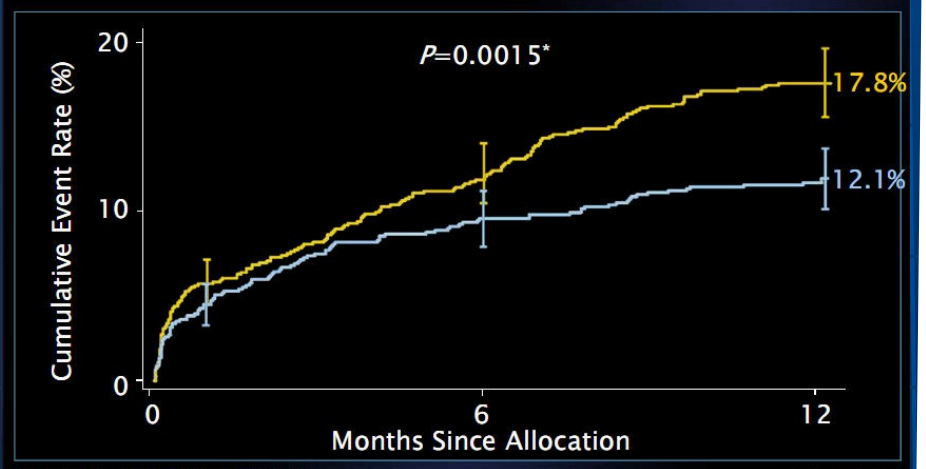
Myocardial Infarction to 12 Months



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

ITT population

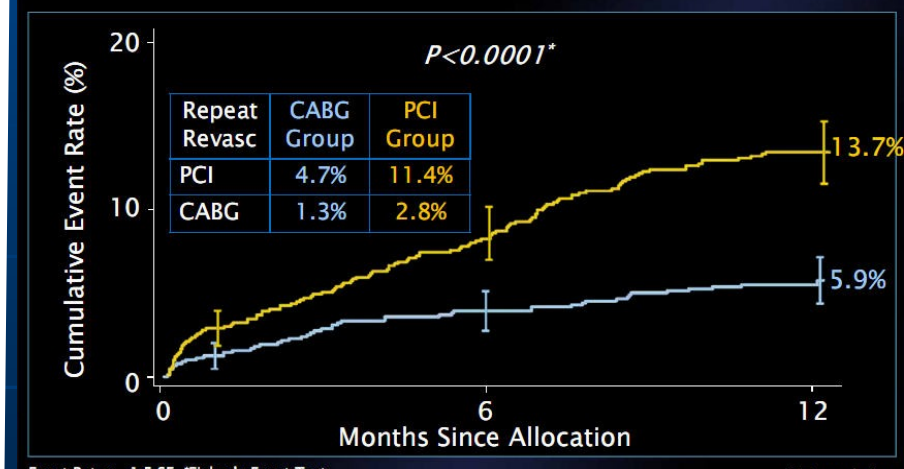
MACCE to 12 Months



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

ITT population

Repeat Revascularization to 12 Months



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

ITT population

Procedural Characteristics
CABG Randomized Cohort

SYNTAX

	CABG N=897
Off-pump surgery, %	15.0
Graft revascularization, %	
At least one arterial graft	97.3
Arterial graft to LAD	95.6
LIMA+venous	78.1
Double LIMA/RIMA	27.6
Complete arterial revascularization	18.9
Radial artery	14.1
Venous graft only	2.6
Grafts per patient, mean ± SD	2.8 ± 0.7
Distal anastomosis/pt, mean ± SD	3.2 ± 0.9

Reasons for Registry Allocation

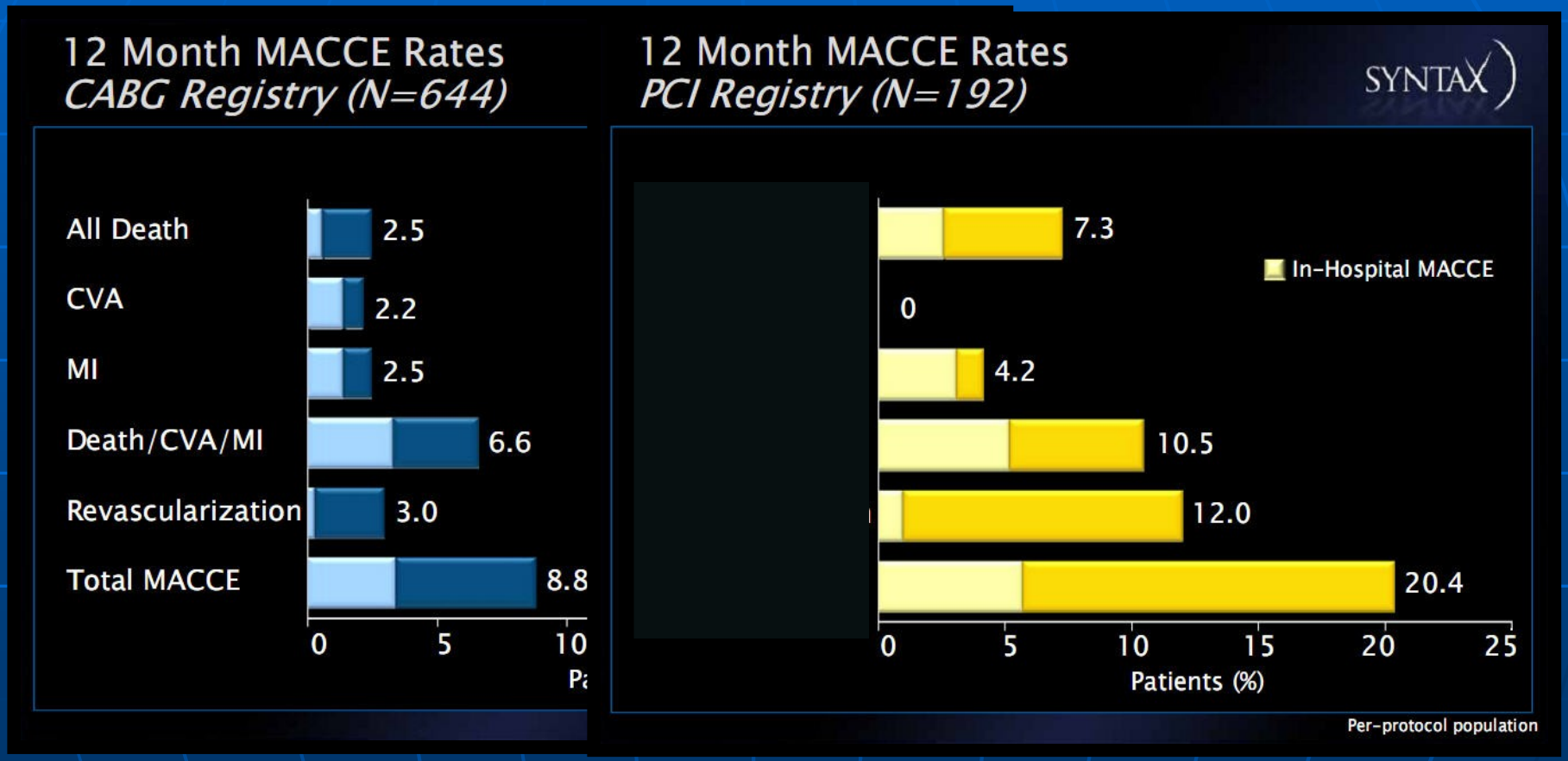
SYNTAX

PCI Registry- CABG ineligible due to:

- Co-morbidities (70.7%)
- No graft material (9.1%)
- Small or poor quality of distal vessel (1.5%)
- Patient refused CABG (5.6%)
- Other (13.1%)

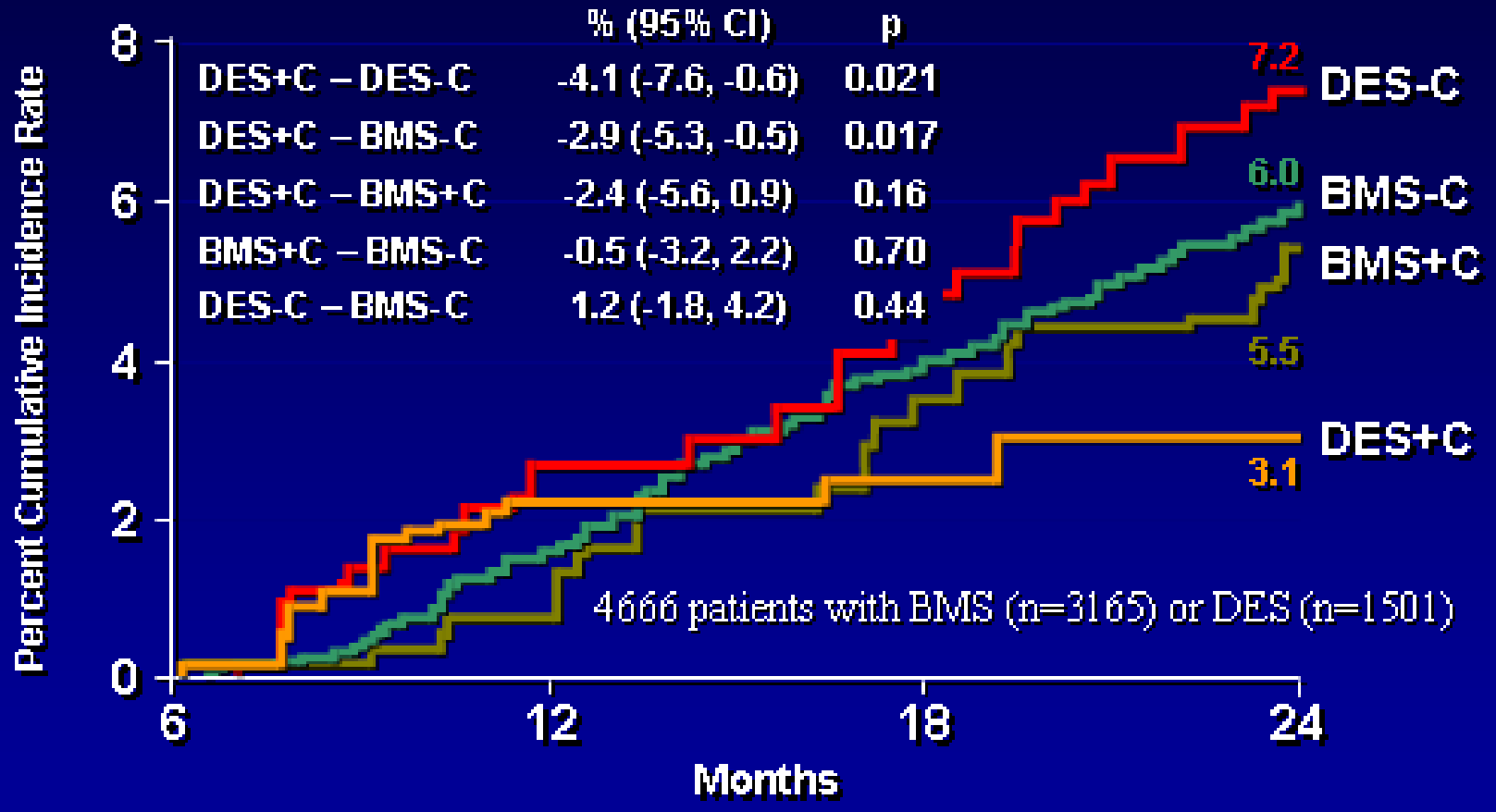
CABG Registry- PCI ineligible due to:

- Complex anatomy (70.9%)
- Untreatable CTO (22.0%)
- Unable to take anti-platelet medications (0.9%)
- Patient refused PCI (0.5%)
- Other (5.7%)


12 Month MACCE Rates
CABG Registry (N=644)
All Death
CVA
MI
Death/CVA/MI
Revascularization
Total MACCE
2.5
2.2
2.5
6.6
3.0
8.8
0
5
10
12 Month MACCE Rates
PCI Registry (N=192)
SYNTAX
In-Hospital MACCE
7.3
0
4.2
10.5
12.0
20.4
0
5
10
15
20
25
Patients (%)
Per-protocol population

6-Month Landmark Analysis

Adjusted Cumulative Rates of Death or Nonfatal MI



E Eisenstein, et al. *JAMA 2007;297:159-168*

Duke Clinical Research Institute
DUKE UNIVERSITY MEDICAL CENTER

Troponin Elevation After Percutaneous Coronary Intervention Directly Represents the Extent of Irreversible Myocardial Injury

Insights From Cardiovascular Magnetic Resonance Imaging

Joseph B. Selvanayagam, MBBS, FRACP; Italo Porto, MD; Keith Channon, MD, FRCP; Steffen E. Petersen, MD; Jane M. Francis, DCCR; Stefan Neubauer, MD, FRCP; Adrian P. Banning, MD, FRCP

Circulation, Mar 2005; 111: 1027 - 1032

antiplatelet therapy. We found that irreversible myocardial injury occurred in ≈30% of patients, despite the use of (preloaded) clopidogrel and abciximab in all patients. The

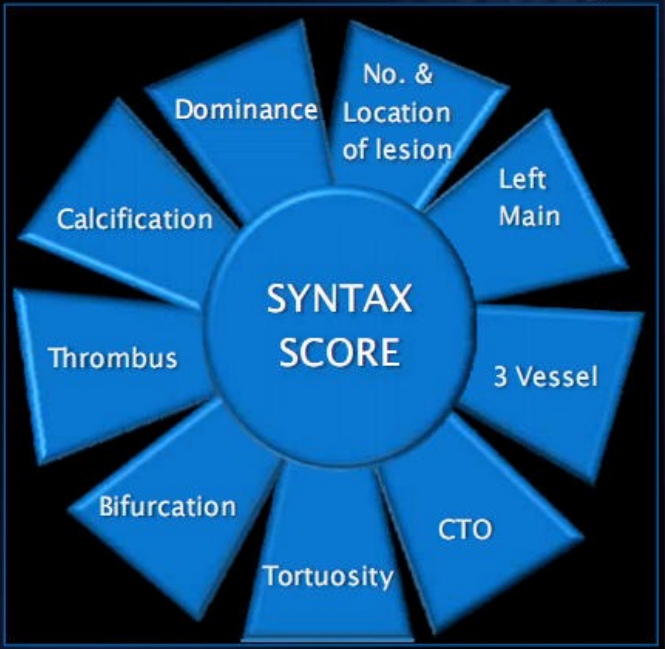
myocardial injury on CMR imaging. In these patients, the magnitude of irreversible injury represented, on average, 5% of total LV mass. Furthermore, we found a strong linear

Patient Profiling

SYNTAX

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

- Patient's operative risk (EuroSCORE & Parsonnet score)
- Coronary lesion complexity (Newly developed SYNTAX score)
- Goal: SYNTAX score to provide guidance on optimal revascularization strategies for patients with high risk lesions



Sianos et al, EuroIntervention 2005;1:219-227
Valgimigli et al, Am J Cardiol 2007;99:1072-1081
Serruys et al, EuroIntervention 2007;3:450-459

BARI classification of coronary segments
Leaman score, Circ 1981;63:285-299
Lesions classification ACC/AHA , Circ 2001;103:3019-3041
Bifurcation classification, CCI 2000;49:274-283
CTO classification, J Am Coll Cardiol 1997;30:649-656

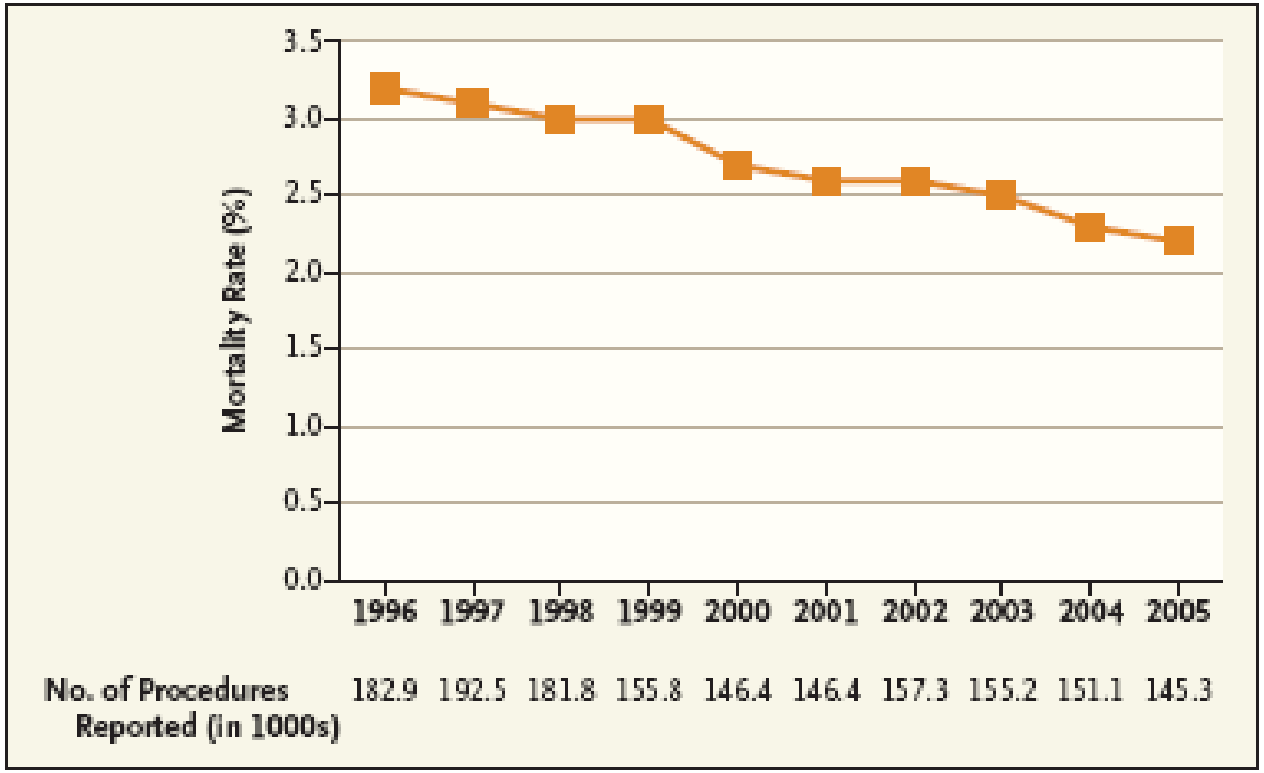
SYNTAX score:

- **Score < 22, no difference PCI vs CABG**
- **Score 22-33, slight advantage for CABG**
- **Score > 33, surgical candidate**

CABG

- CABG DEALS WITH THE ‘CULPRIT’ LESION AND ANY **FUTURE** CULPRIT LESION (because graft is to mid vessel) BUT PCI only deals with ‘suitable’ culprit lesion

- CABG – **COMPLETE** revascularization



Unadjusted Operative Mortality Associated with Coronary-Artery Bypass Grafting in the United States, 1996–2005.

Data are from the Society of Thoracic Surgeons' adult cardiac database, spring 2006 report (prepared by the Duke Clinical Research Institute). The database currently receives data from about three quarters of all U.S. sites that perform cardiac surgery; participation rates have varied in previous years. Operative mortality includes all deaths before hospital discharge, as well as deaths after discharge but within 30 days after the procedure, unless the cause was clearly unrelated. Patients undergoing repeat surgery are included; those also undergoing aortic or mitral valve replacement are excluded.

The Society of Thoracic Surgeons: 30-Day Operative Mortality and Morbidity Risk Models

A. Laurie W. Shroyer, PhD, Laura P. Coombs, PhD, Eric D. Peterson, MD, Mary C. Eiken, MSN, Elizabeth R. DeLong, PhD, Anita Chen, MS, T. Bruce Ferguson, Jr, MD, Frederick L. Grover, MD, and Fred H. Edwards, MD

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Number of records = 503,478 CABG-only records.

Table 2. Preoperative Estimation of Risk of Mortality, Cerebrovascular Accident, and Mediastinitis

For use only in isolated CABG surgery

Directions: Locate outcome of interest, e.g., mortality. Use the score in that column for each relevant preoperative variable; then sum these scores to get the total score. Take the total score and look up the approximate preoperative risk in the table on page 8.

Patient or Disease Characteristic	Mortality Score	CVA Score	Mediastinitis Score
Age 60–69	1.5	1.5	1
Age 70–79	2.5	2.5	1.5
Age ≥ 80	6.5	3	2
Female sex	2	1.5	
Obesity (BMI 31–36)			2
Severe Obesity (BMI ≥ 37)			4.5
Diabetes	1	1.5	1.5
COPD	2		2
PVD	1.5	1.5	
Dialysis	4	2	3
Creatinine ≥ 2	2	2	
MI ≤ 7 days	1.5		
Prior CABG	2.5		
LVEF < 40%	2	1.5	1.5
3-Vessel Disease	1.5		
LM 50–89%	1.5		
LM 90%	2		
WBC > 12K	2.5		
Urgent surgery	2	1.5	2
Emergency surgery	5	3.5	2
Total Score			

Table 2 continued

Preoperative Risk

Total Score	Mortality %	CVA %	Mediastinitis %
0	0.2	0.4	0.3
1	0.2		0.3
2	0.3	0.6	0.4
3	0.3	0.9	0.5
4	0.5	1.3	0.7
5	0.7	1.4	0.9
6	1.0	2.0	1.3
7	1.3	2.7	1.7
8	1.8	3.4	2.5
9	2.3	4.2	3.2
10	3.0	5.9	4.2
11	4.0	7.6	5.6
12	5.3	≥ 10.0	≥ 7.3
13	6.9		
14	8.8		
15	11.5		
16	14.1		
17	18.7		
18	≤ 23.0		

American Heart Association.

What Constitutes Optimal Surgical Revascularization?

Answers From the Bypass Angioplasty Revascularization Investigation (BARI)

Thomas J. Vander Salm, MD, FACC,* Kevin E. Kip, PHD,† Robert H. Jones, MD, FACC,‡ Hartzell V. Schaff, MD, FACC,§ Richard J. Shemin, MD, FACC,‖ Gabriel S. Aldea, MD, FACC,¶ Katherine M. Detre, MD, DRPH, FACC†

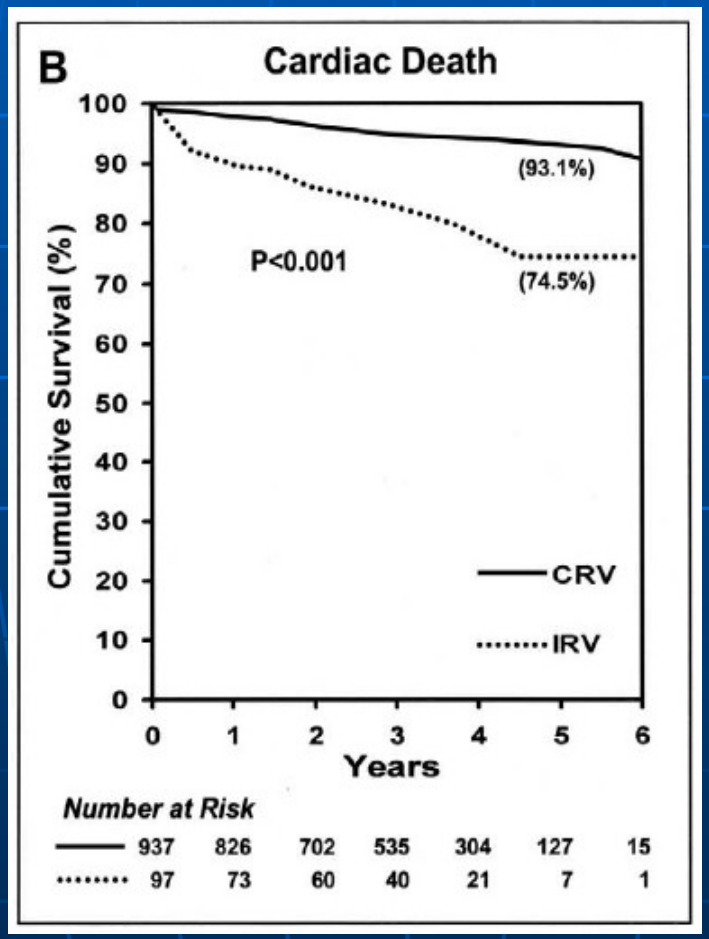
J. Am. Coll. Cardiol. 2002;39;565-572

- **Controversial**
- ***Definition 1*: "Traditional"** revascularization was defined as all diseased arterial systems receiving at least one graft insertion.
- ***Definition 2***: **"Functional"** revascularization was defined as bypassing all diseased "primary" coronary segments (LAD, LCX, RCA)

Nondiseased vessel : **<1.5 mm** in diameter regardless of the degree of stenosis, or with a stenosis of **<50%.**

In the current era, complete revascularization improves survival after coronary artery bypass surgery

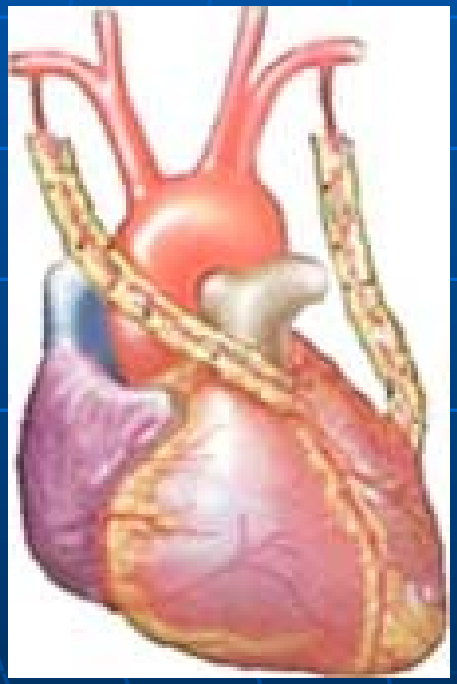
Thomas Kleisli, BS, Wen Cheng, MD, Milagros J. Jacobs, MPH, James Mirocha, MS, Michele A. DeRobertis, RN, Robert M. Kass, MD, Carlos Blanche, MD, Gregory P. Fontana, MD, Sharo S. Raissi, MD, Kathy E. Magliato, MD, and Alfredo Trento, MD

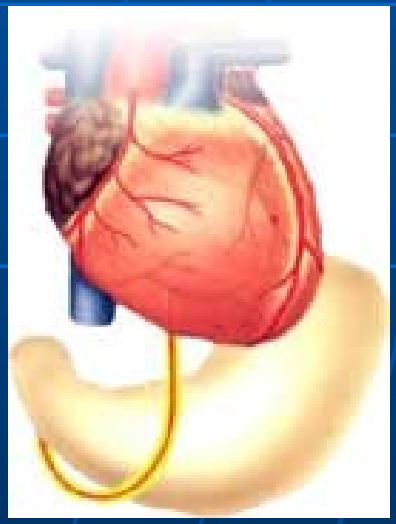


1034pt's

J Thorac Cardiovasc Surg 2005;129:1283-1291

Arterial Re vascularization





LIMA + RIMA

- Resistance to atherosclerosis.
- Production of vasodilators **nitric oxide** and **prostacyclin** - "downstream" effect
- Response to : vasodilators (milrinone + nitroglycerin)
- No Response to Norepinephrine.
- Remodeling - adapting to demand

Effect of LIMA

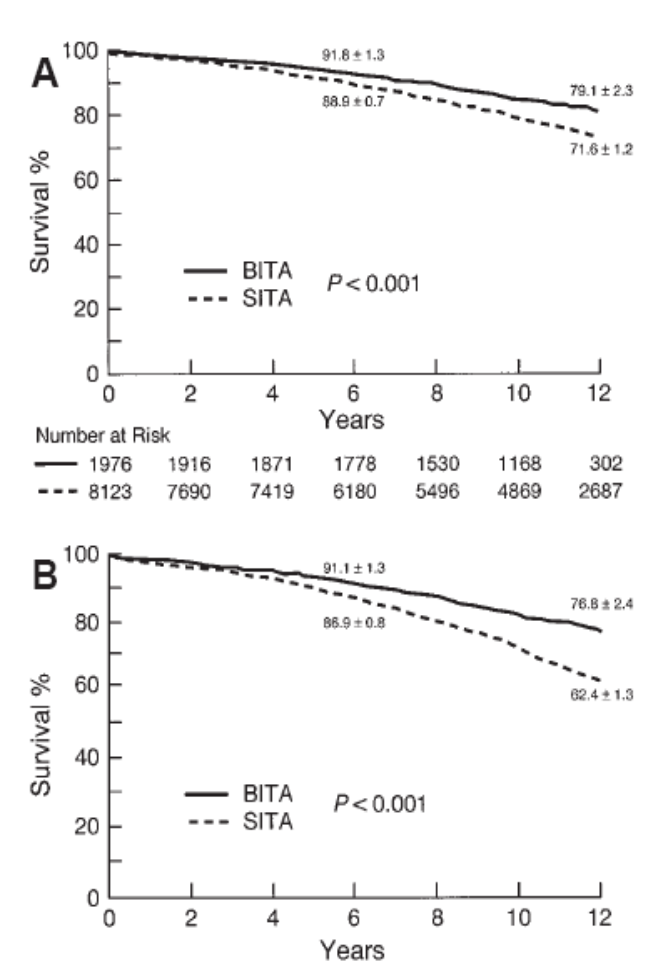
- SVG compared to LIMA to LAD:
  - X 1.61 risk of death in 10 y
  - X 1.41 risk of late MI
  - X 2.00 risk of re-operation

Loop et al, N Engl J Medicine 1986

TWO INTERNAL THORACIC ARTERY GRAFTS ARE BETTER THAN ONE

Bruce W. Lytle, Eugene H. Blackstone, Floyd D. Loop, Penny L. Houghtaling, John H. Arnold, Rami Akhrass, Patrick M. McCarthy and Delos M. Cosgrove

J Thorac Cardiovasc Surg 1999;117:855-872



Comparison of the bilateral ITA *(BITA)* and single ITA *(SITA)* groups in terms of survival **(A)** and reoperation-freesurvival **(B).**

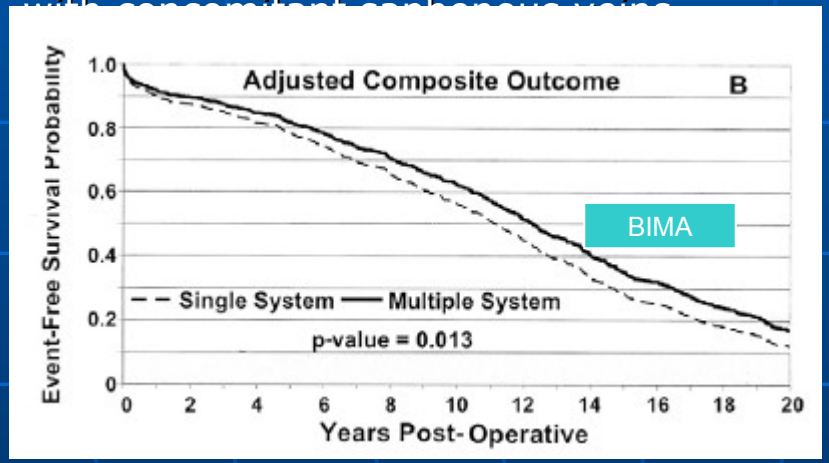
Effect of Bilateral IMA

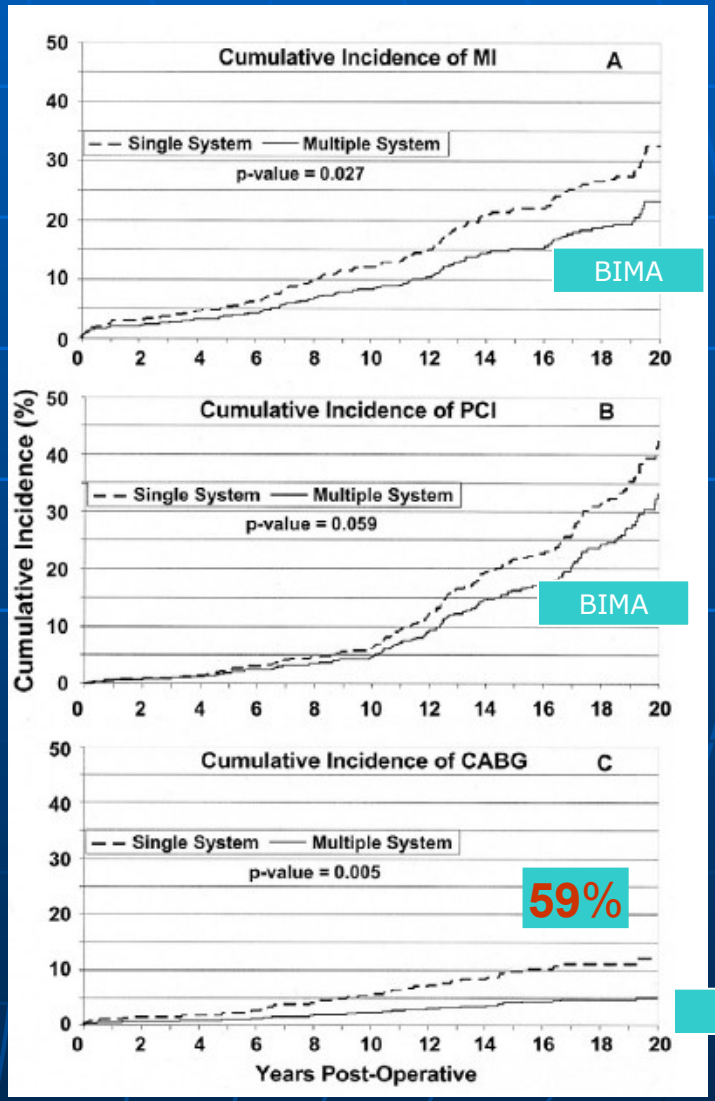
- 10 y outcomes:
  - 76% survival compared with 85% with bilateral IMA
    - *Pick et al Ann Thoracic Surg 1997*
- 20 y outcomes:
  - Bilat IMA had improved survival and reduced re-interventions
    - Lytle et al, Ann Thorac Surg 2004

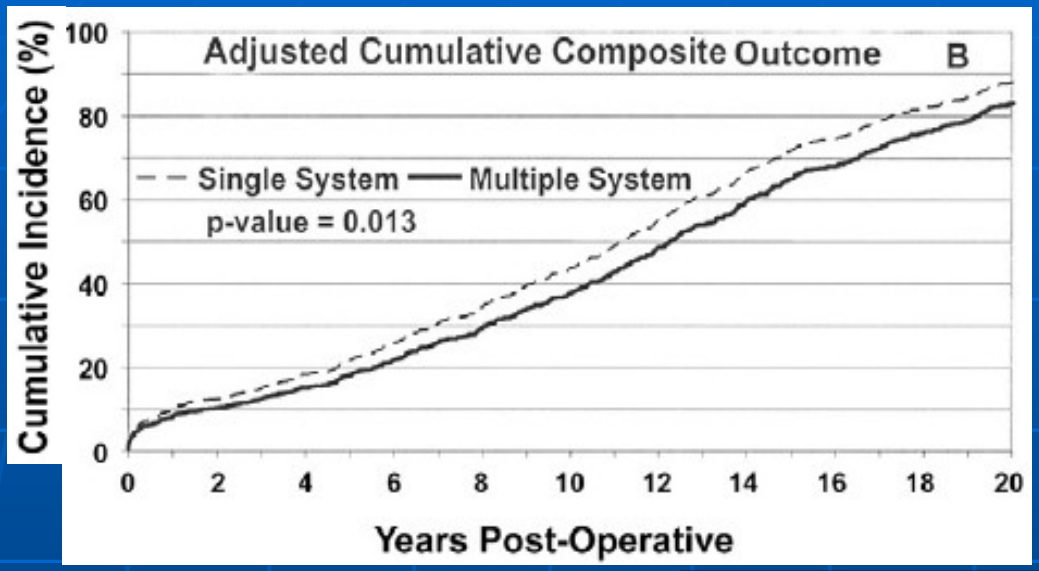
Techniques and Benefits of Multiple Internal Mammary Artery Bypass at 20 Years of Follow-Up

(Ann Thorac Surg 2007;83:1008–15)

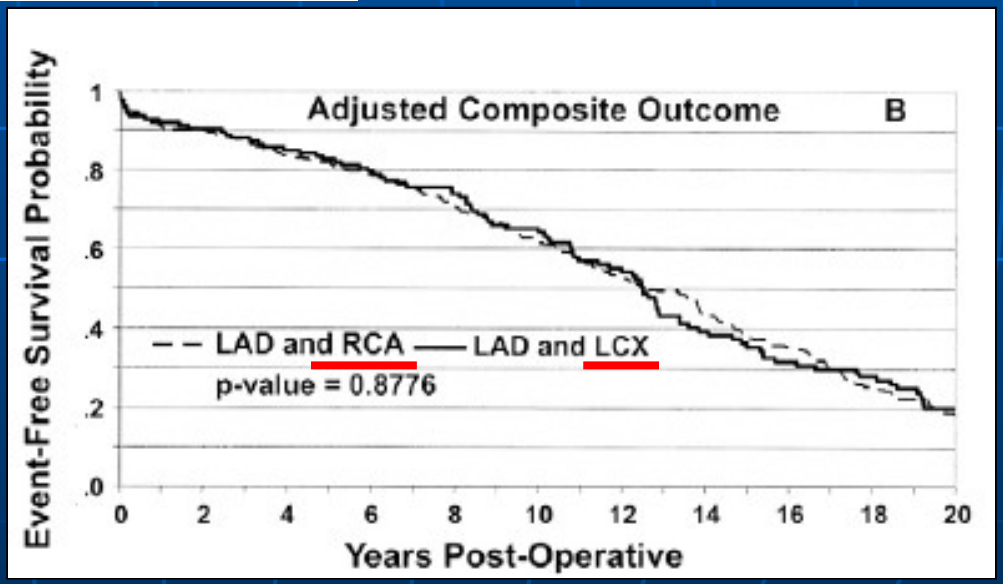
- Single (SIMA) IMA grafts were used in **490**
- Multiple (MIMA) IMA grafts in **377**, along with concomitant saphenous veins





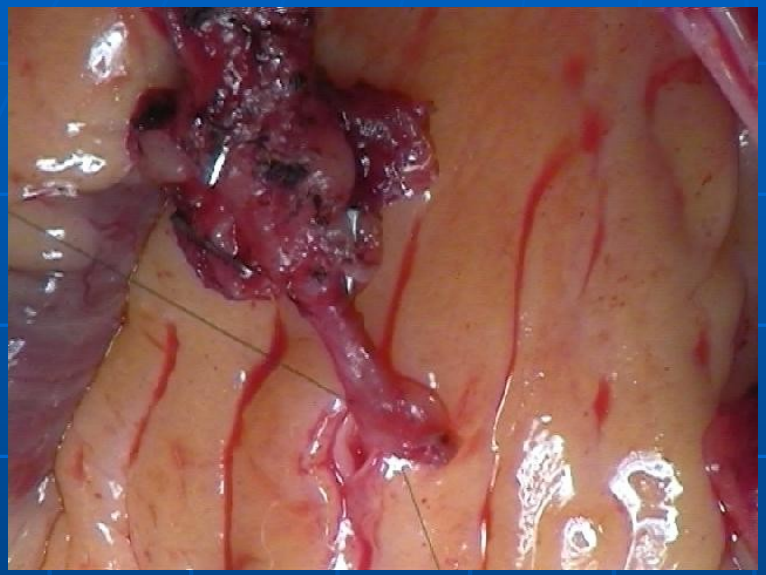


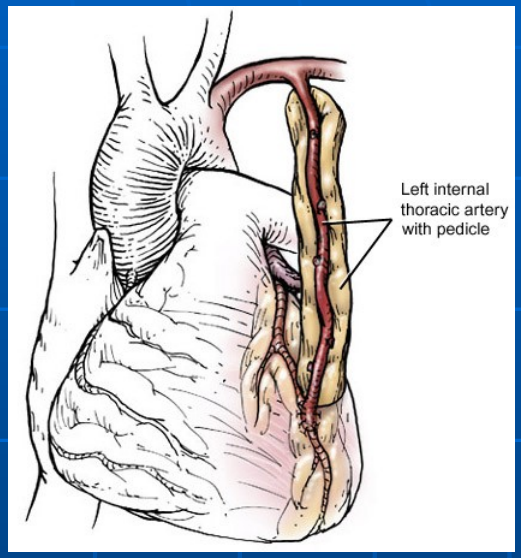
One year gained



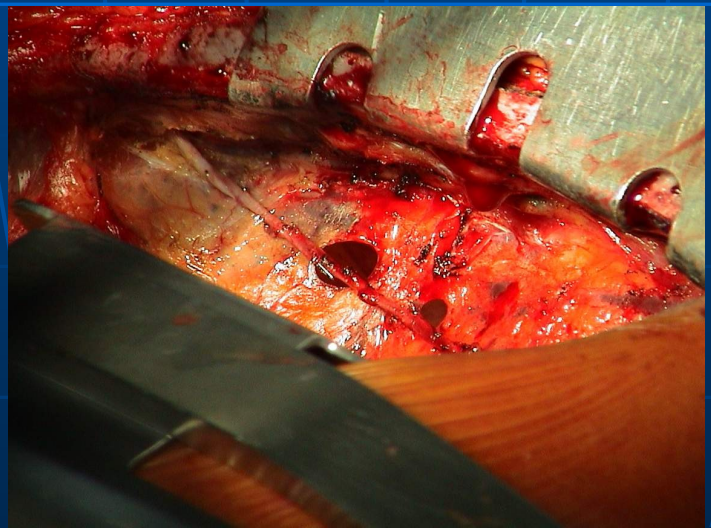
(Ann Thorac Surg 2007;83:1008–15)

Pedicled

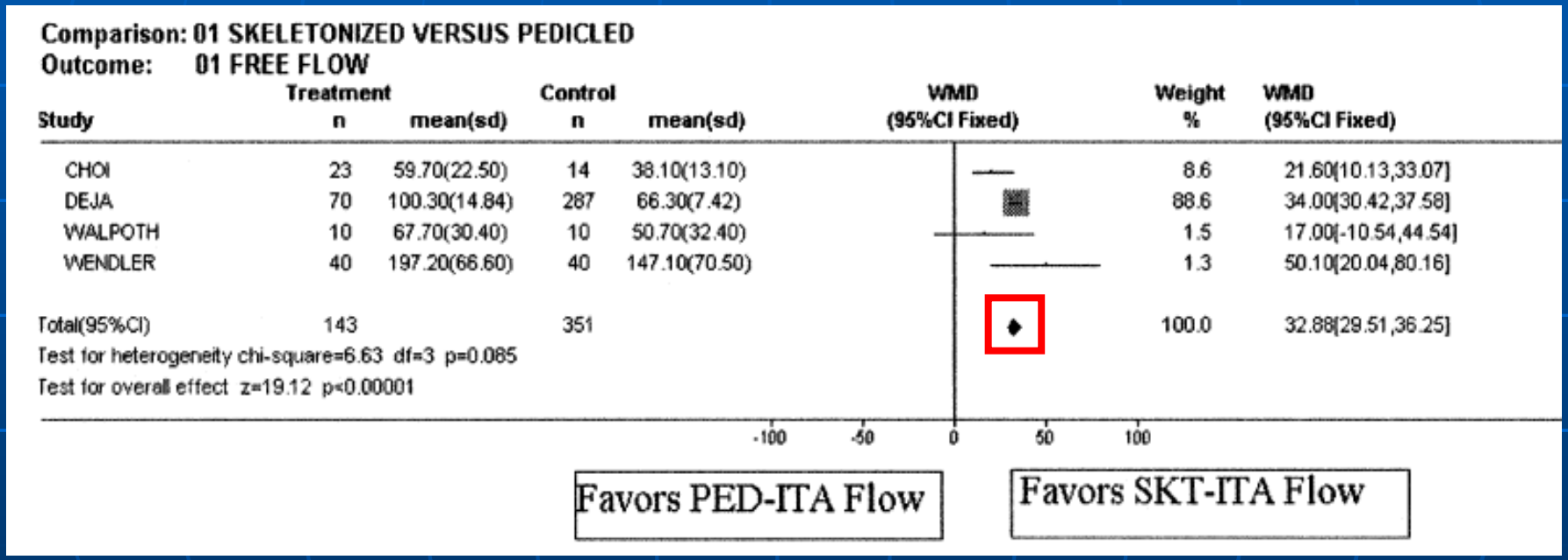




Skeletonized



Should the Internal Thoracic Artery Be Skeletonized?

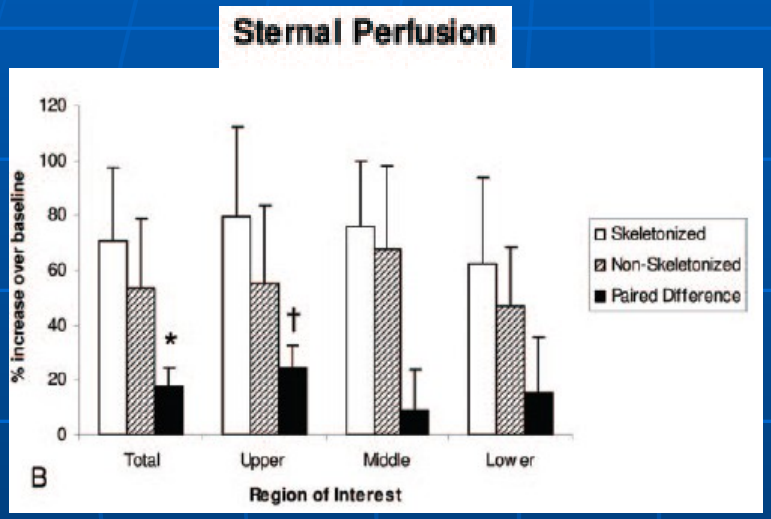


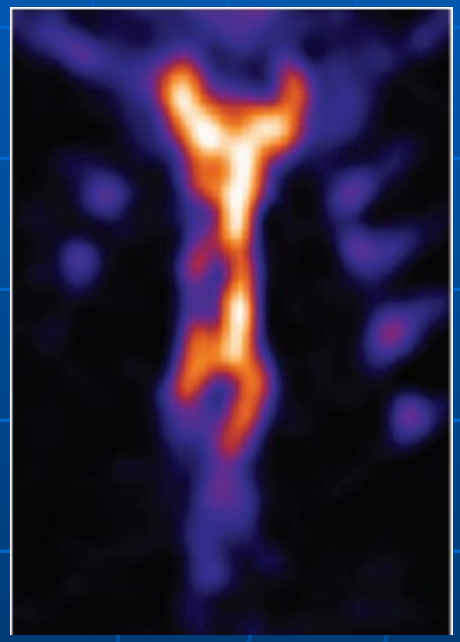
Flow of ITA harvested as pedicled or skeletonized conduit.

(Ann Thorac Surg 2004;77:2238–46)

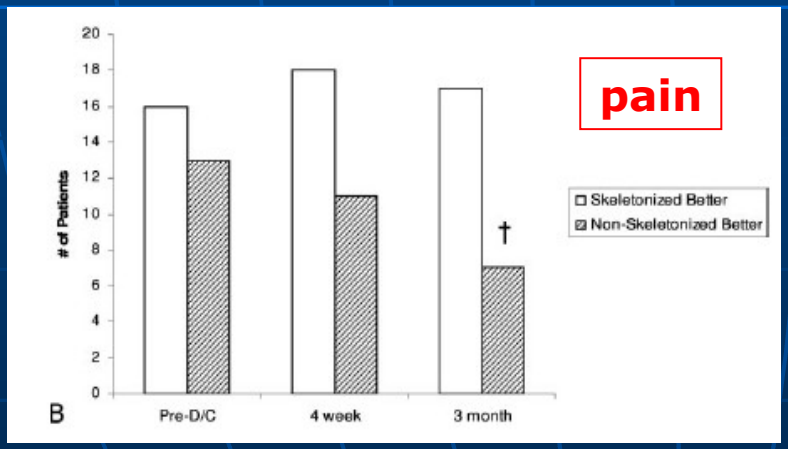
Skeletonized Internal Thoracic Artery Harvest Reduces Pain and Dysesthesia and Improves Sternal Perfusion After Coronary Artery Bypass Surgery

A Randomized, Double-Blind, Within-Patient Comparison



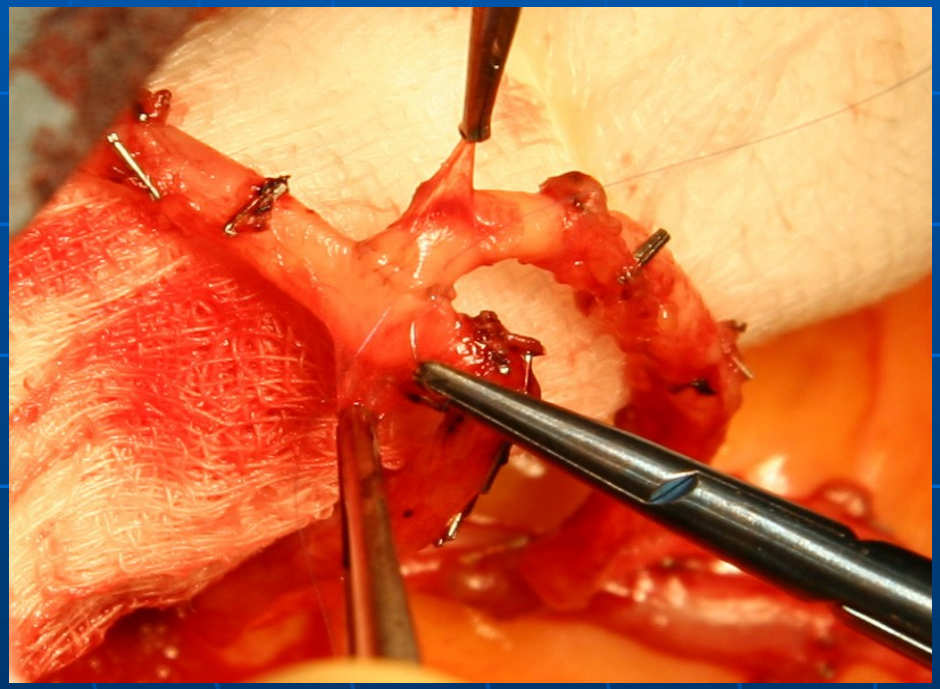


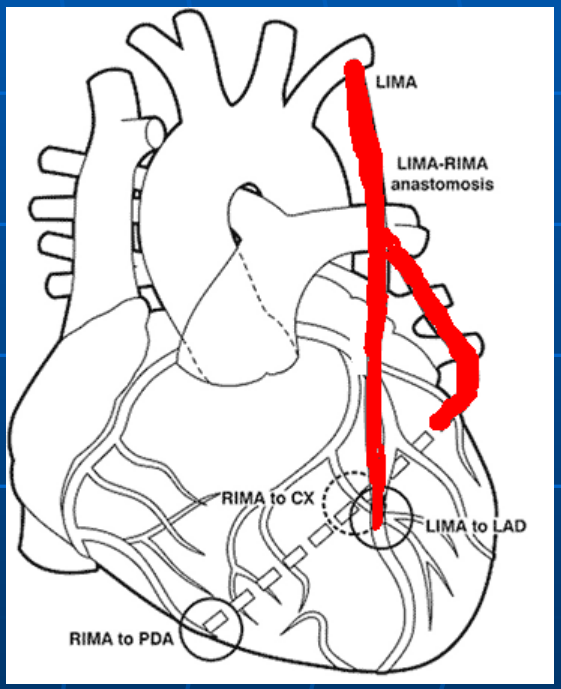
Lt skeletonized and a Rt nonskeletonized



Circulation. 2006;114:766-773

T garft





Adequacy of Flow Capacity of Bilateral Internal Thoracic Artery T Graft

Masami Ochi, MD, Nobuo Hatori, MD, Ryuzo Bessho, MD, Masahiro Fujii, MD, Yoshiaki Saji, MD, Shigeo Tanaka, MD, and Hiroshi Honma, MD

- **40 pt's**
- **6 months - angiography**

Table 1. Destination of ITA and Other Grafts

Coronary Artery	LITA	RITA	GEA (n = 16)	RA (n = 5)	SVG (n = 12)
LAD	40				
Diagonal	16	12			
IM		11			
OM		30			
PL		22			
RCA			19	5	14
Sequential graft	16	26	3	0	2

Table 2. Angiographic Findings of the Lumen of Each Segment of the T Graft

	Luminal Narrowing			
	Normal	Mild–Moderate	Stringlike	Occlusion
LITA				
Main stem	40			
Distal	37	3	0	0
RITA				
Proximal	40			
Distal	35	4	1	0
T-Anastomosis	39	1	0	0

(Ann Thorac Surg 2001;72:2008–12)

Contemporary Coronary Graft Patency: 5-Year Observational Data From a Randomized Trial of Conduits

Philip A. R. Hayward, FRCS, and Brian F. Buxton, FRACS

Department of Cardiac Surgery, Austin Hospital, Heidelberg, Melbourne, Australia

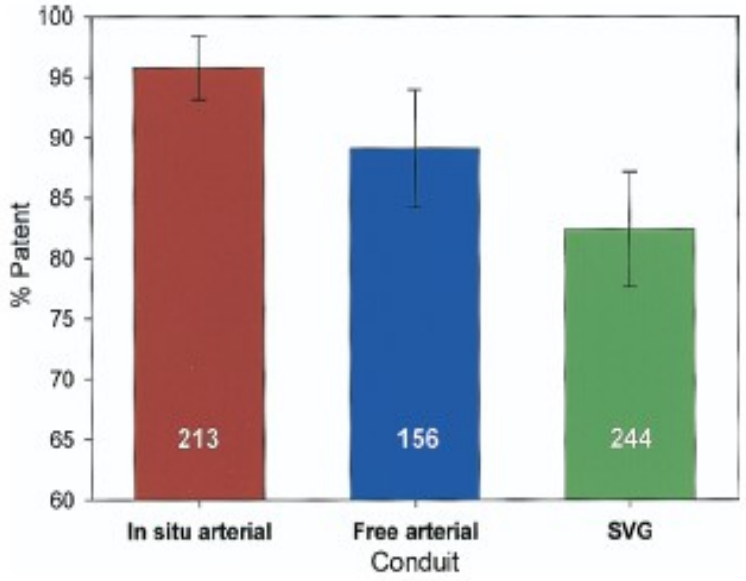


Fig 1. Five-year patency of three subgroups of conduits. Fisher's exact test: in situ versus free arterial, p = 0.02; in situ versus saphenous vein graph (SVG), p < 0.0001; and free arterial versus SVG, p = 0.08.

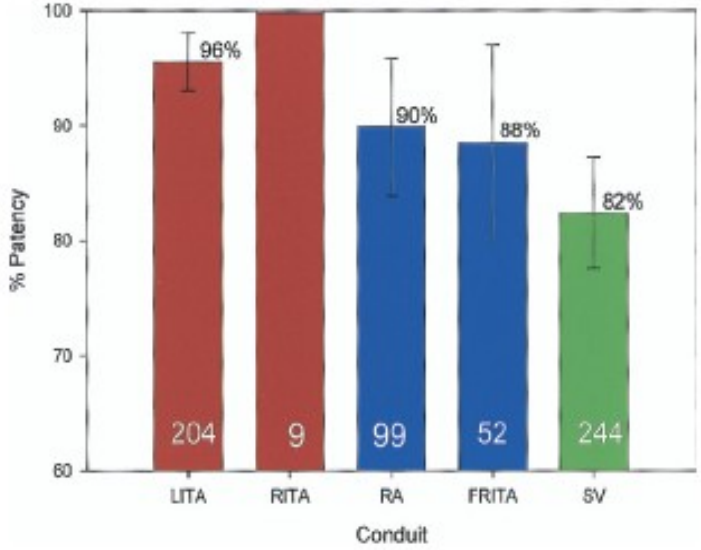


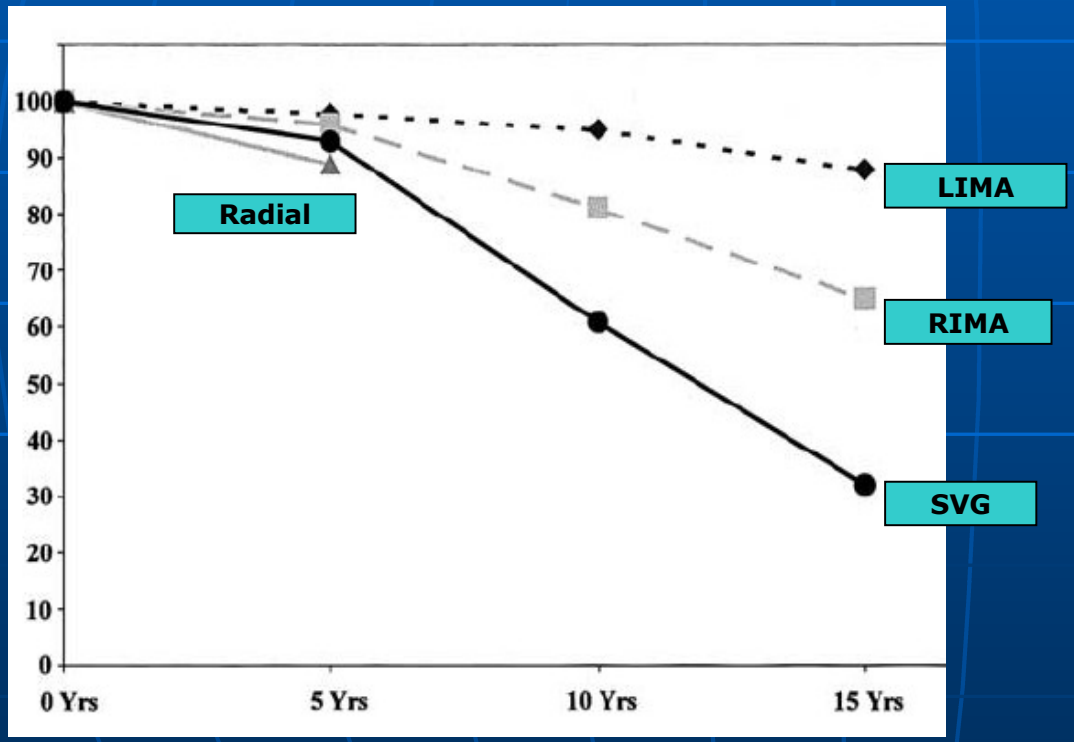
Fig 3. Comparative patencies of different in situ and free arterial conduits at 5 years. Fisher's exact test: left internal thoracic artery (LITA) versus right internal thoracic artery (RITA), p = 0.7; and radial artery (RA) versus free right ITA (FRITA), p = 0.5. (SV = saphenous vein.)

(Ann Thorac Surg 2007;84:795–800)

Patencies of 2,127 Arterial to Coronary Conduits Over 15 Years

James Tatoulis, FRACS, Brian F. Buxton, FRACS, and John A. Fuller, FRACP

Royal Melbourne Hospital and Epworth Hospital, University of Melbourne, Melbourne, Victoria, Australia



At **10** ; **15 yrs**

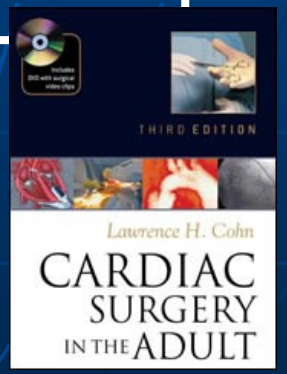
LITA - 95 and 88%

SVG - 61 and 32%

Ann Thorac Surg 2004;77:93–101

: Radial artery

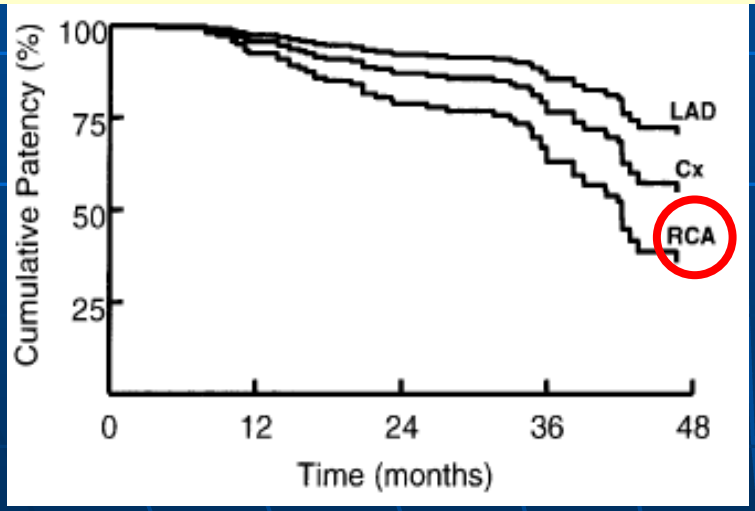
- 5-year patency : 83 - 95%
- Very susceptible to competitive flow.
- The graft failure rate is higher if :
  - The target vessel stenosis is less than severe
  - On the right coronary system.



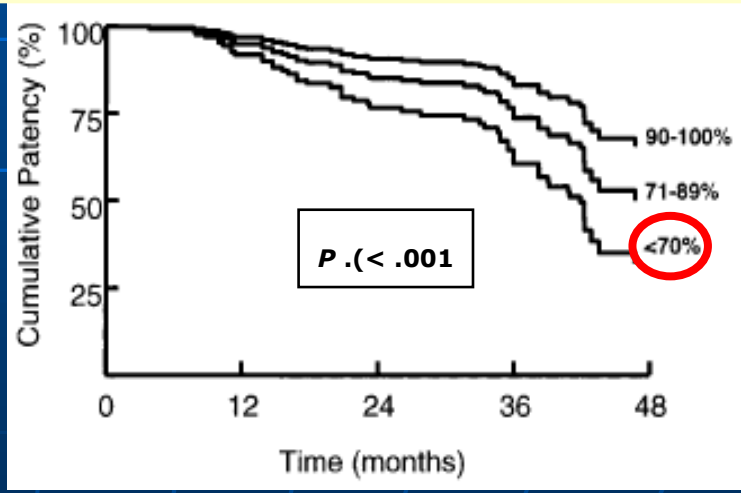
Effect of target stenosis and location on radial artery graft patency

- 231 radial artery anastomoses
- Angiography -109 patients
- Mean 27.1 mo postOP for symptoms of ischemia

Cumulative patency for RA anastomotic locations.



Cumulative RA patency associated withproximal target stenosis:



The relative risks for the targets of the RCA were statistically significant versus those of the LAD (*P* = .01) and bordered on significance versusthose of the circumflex artery

J Thorac Cardiovasc Surg 2002;123:45-52

Bilateral Radial Artery Grafts in Coronary Reconstruction: Technique and Early Results in 261 Patients

James Tatoulis, FRACS, Brian F. Buxton, FRACS, and John A. Fuller, FRACP
Departments of Cardiac Surgery, Royal Melbourne and Epworth Hospitals, University of Melbourne, Victoria, Australia

Conclusions. Bilateral RA to coronary grafting extends the scope of arterial myocardial revascularization, and is safe. Late angiographic results are required.

(Ann Thorac Surg 1998;66:714–20)

Impact of Radial Artery Cannulation for Coronary Angiography and Angioplasty on Radial Artery Function

Jason M. Burstein, MD[a], Dominica Gidrewicz, MSc[b], Stuart J. Hutchison, MD[b,c], Kate Holmes, RVT[c], Sanjit Jolly, MD[c], and Warren J. Cantor, MD[b,d,*]

This study has important implications for cardiologists performing transradial procedures and for the selection of conduits by cardiac surgeons. For patients who are likely to require bypass surgery using a radial conduit, it may be prudent to avoid radial access for coronary angiography.

(Am J Cardiol 2007;99:457–459)

Gstroepiploic

LATE ANGIOGRAPHIC RESULT OF USING THE RIGHT GASTROEPIPLOIC ARTERY AS A GRAFT

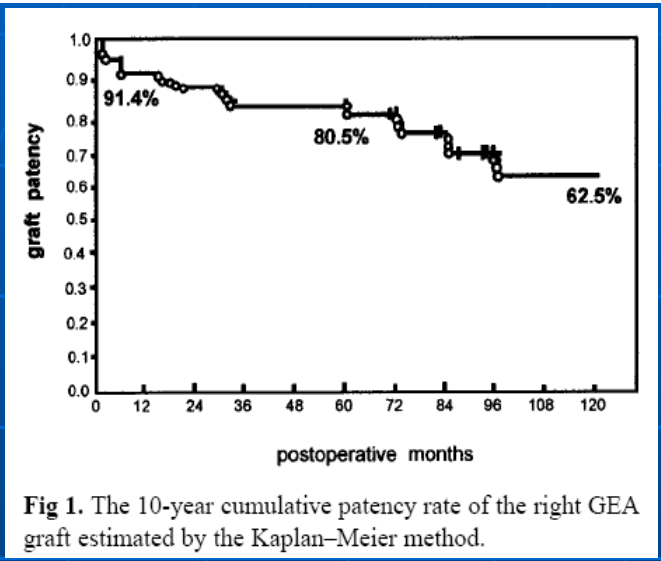
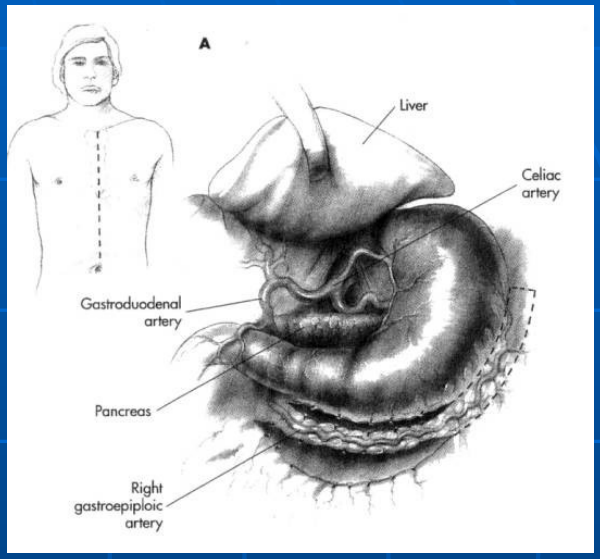


Fig 1. The 10-year cumulative patency rate of the right GEA graft estimated by the Kaplan–Meier method.



***J Thorac Cardiovasc Surg* 2000;120:496-498**

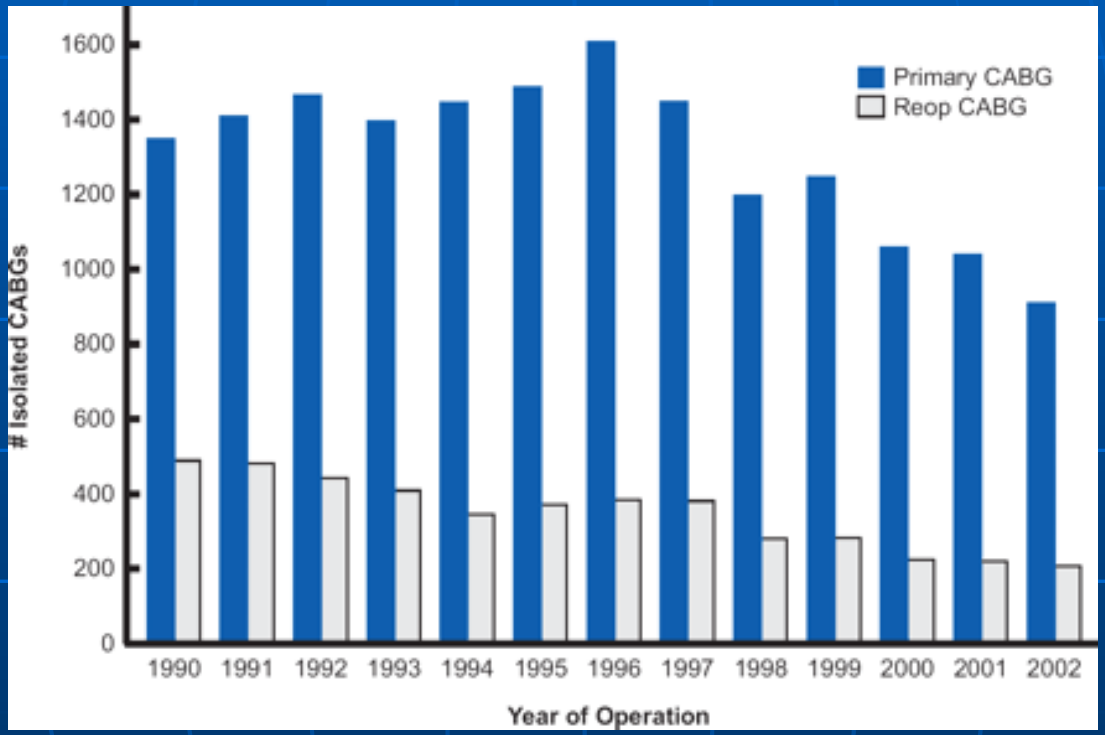
Table 1. Early, Mid- and Long-Term Postoperative Gastroepiploic Artery Patency Rate

Anastomosed Method (average of follow up duration)	Sequence	Early Result (n = 67)	Mid- and Long-Term Result (n = 49)
GEA-LAD (102 months)		94.1% (16/17)	57.1% (8/14)
GEA-LAD-Dx (126 months)	GEA-LAD	100% (8/8)	66.7% (2/3)
	LAD-Dx	100% (8/8)	66.7% (2/3)
GEA-RCA-LAD (96 months)	GEA-RCA	100% (3/3)	100% (1/1)
	RCA-LAD	33.3% (1/3)	0% (0/1)
GEA-Cx (98 months)		100% (14/14)	91.7% (11/12)
GEA-Cx-Cx (101 months)	GEA-Cx	100% (4/4)	100% (3/3)
	Cx-Cx	75% (3/4)	66.7% (2/3)
GEA-RCA-Cx (108 months)	GEA-RCA	100% (21/21)	87.5% (14/16)
	RCA-Cx	80.9% (17/21)	71.4% (10/14)
GEA-RCA only in the same duration (112 months)		98.1% (155/158)	93.8% (120/128)

Cx = circumflex artery; Dx = diagonal branch; GEA = gastroepiploic artery; LAD = left anterior descending coronary artery; RCA = right coronary artery.

Ann Thorac Surg 2004;78:2033– 6

Coronary Artery Reoperations



21,568 pt's who underwent bypass surgery from **1990 - 2003** showed a **steady decrease** in the number of patients undergoing redo coronary artery operations.

Is Reoperation Still a Risk Factor in Coronary Artery Bypass Surgery?

Joseph F. Sabik III, MD, Eugene H. Blackstone, MD, Penny L. Houghtaling, MS, Peter A. Walts, MD, and Bruce W. Lytle, MD

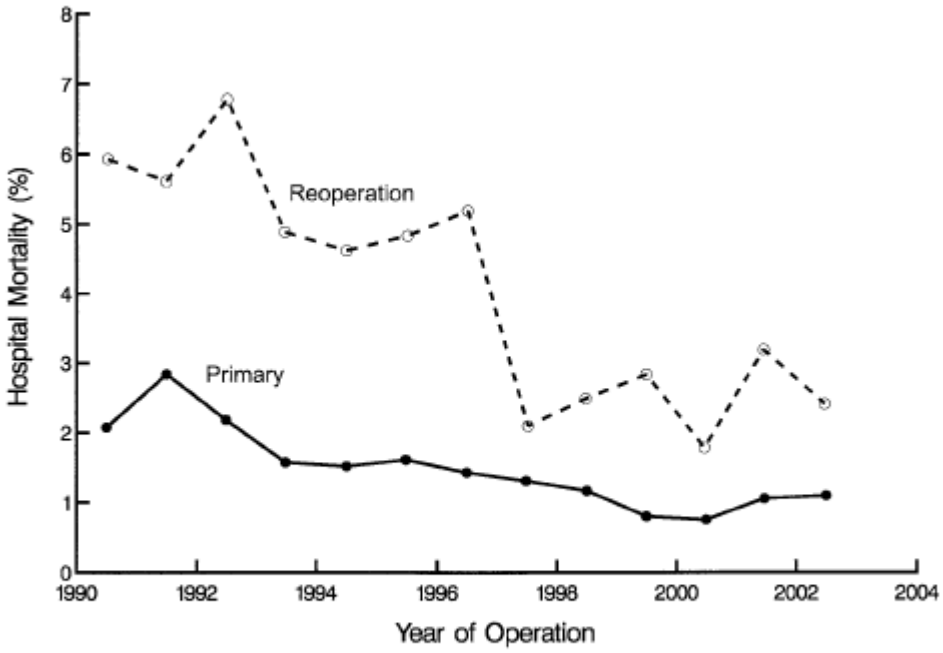


Fig 2. Hospital mortality after primary and reoperative coronary artery bypass grafting according to year of operation.

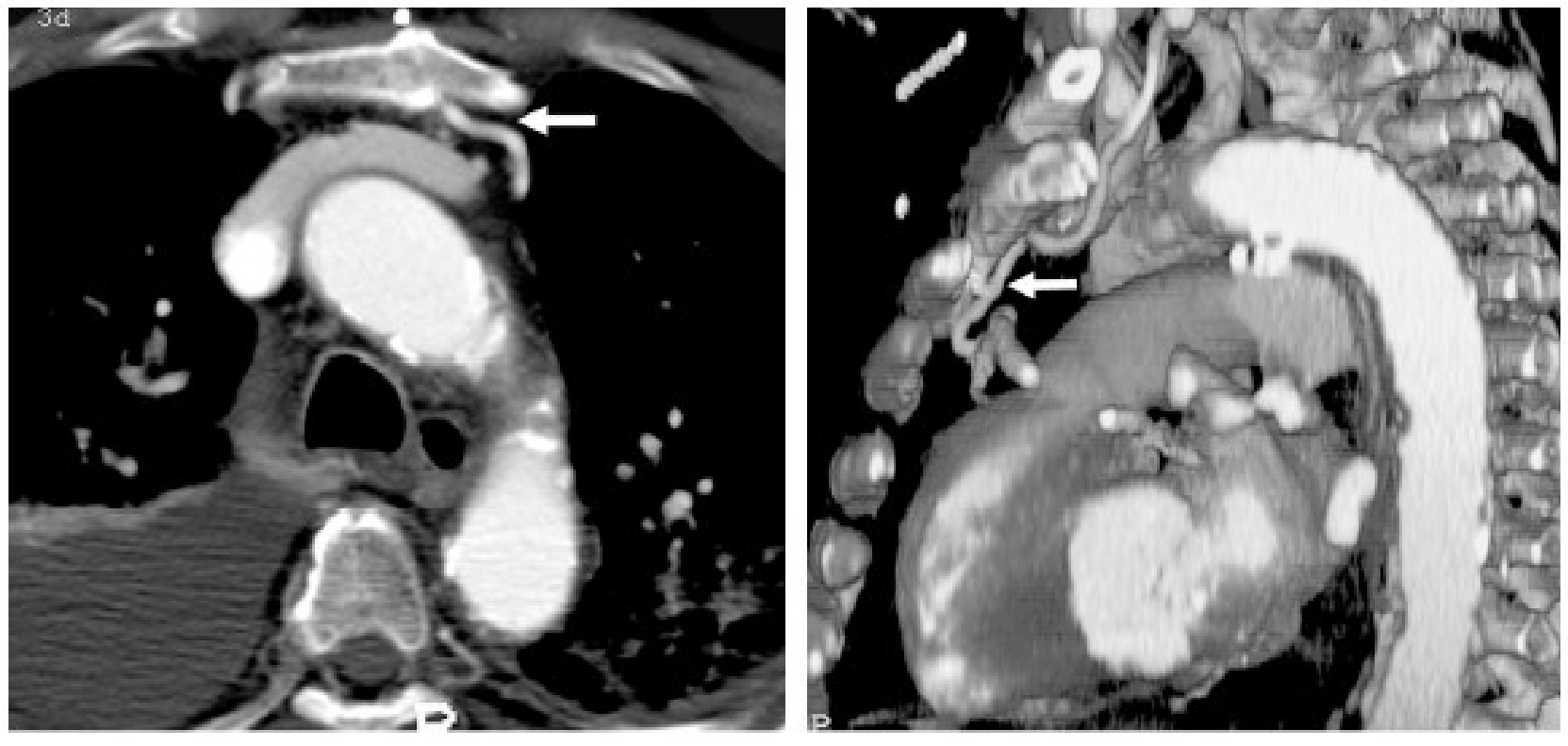
(Ann Thorac Surg 2005;80:1719–27)

RESULTS OF CORONARY ARTERY REOPERATIONS

- STS database - in-hospital mortality rate of **6.95%** (1991–1993).
- Recent mortality rates from other large series range from **4.2 to 11.4%** , most being around **7%.**

2-5 times **higher** than the risk of primary CABG.

CORONARY ARTERY REOPERATIONS

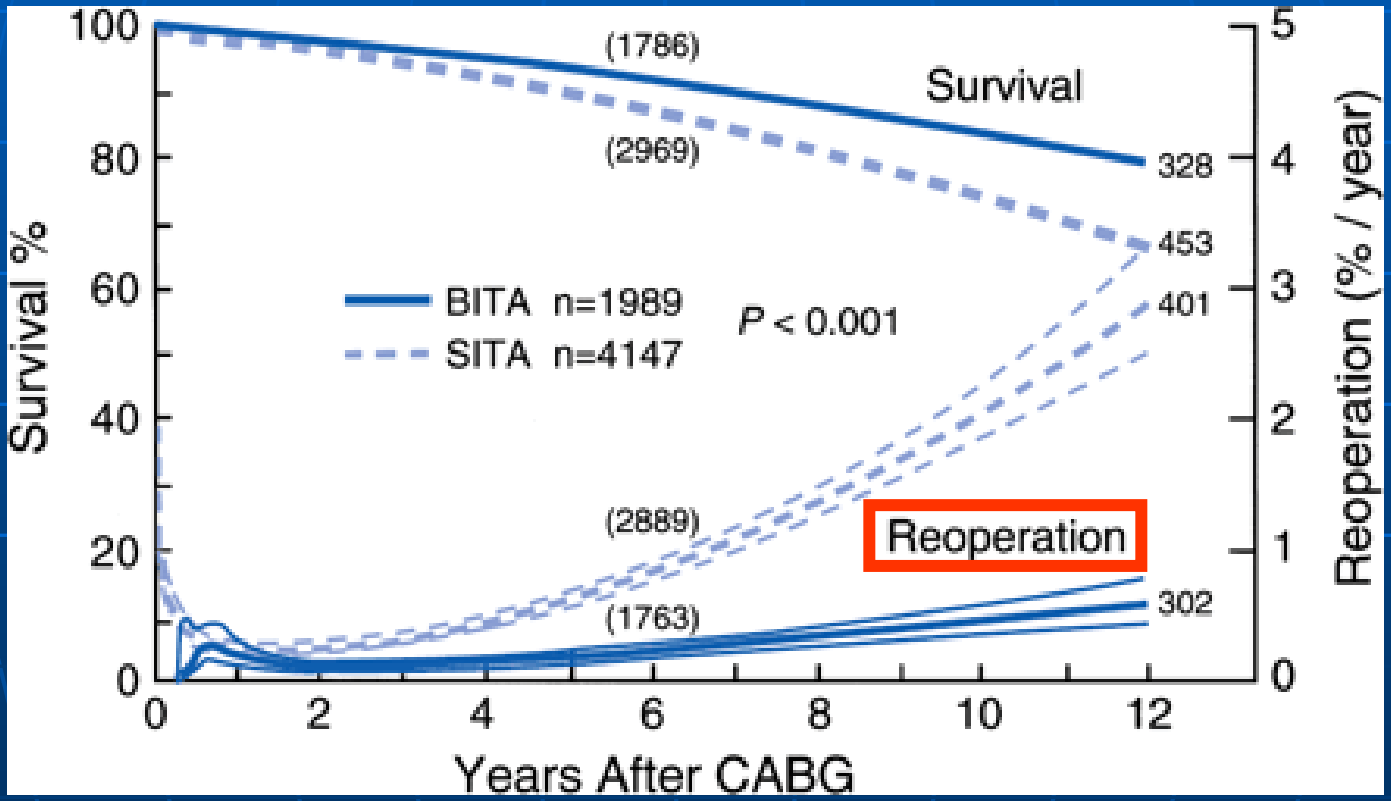


Axial CT image :
Preoperative assessment for aortic valve replacement in a 67-year-old man who had undergone CABG.

TWO INTERNAL THORACIC ARTERY GRAFTS ARE BETTER THAN ONE

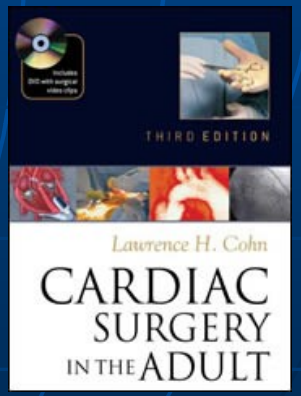
Bruce W. Lytle, Eugene H. Blackstone, Floyd D. Loop, Penny L. Houghtaling, John H. Arnold, Rami Akhrass, Patrick M. McCarthy and Delos M. Cosgrove

J Thorac Cardiovasc Surg 1999;117:855-872

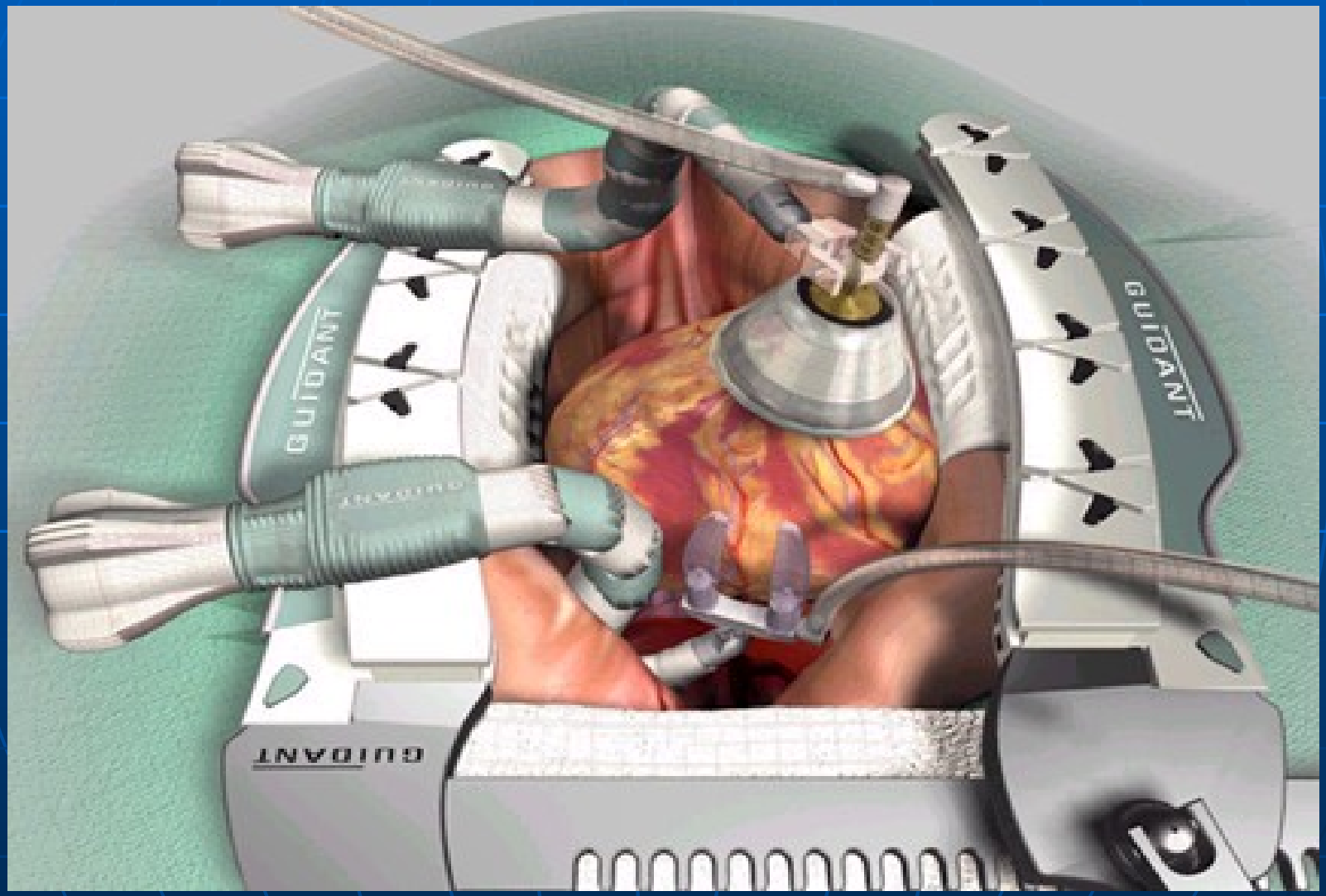


Factors favoring PTCA

- Early (<5 years) stenoses
- Single stenotic vein graft
- Focal graft lesions
- Patent ITA-LAD graft
- Normal left ventricular function

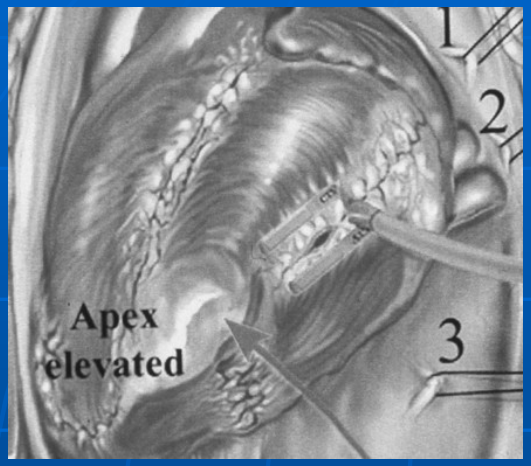


Off Pump Coronary Bypass



חסרונות C.P.B

- פגיעה במערכת קרישת הדם
- שפעול המנגנון הדלקתי בגוף inflamatory response
- הפרעה בזילוח הרקמתי- ריאות , כליות
- נזקים נוירולוגים
- הפרעות קוגניטיביות



Off PUMP

- Revascularization without the potential complications of extracorporeal support.
- 20 - 25% of all procedures performed in the United States.
- **Completeness of Revascularization** and **Graft Patency ?**
- Technically demanding
- Learning curve

Off Pump Coronary Bypass

- Only 1 randomized study 200 patients:
  - Similar graft patency, similar cardiac outcomes, lower cost…..
    - *Puskas et al, JAMA 2004*

Off-pump coronary artery bypass surgery may be superior to conventional CABG in many patients, especially those who are considered "high-risk"[1]

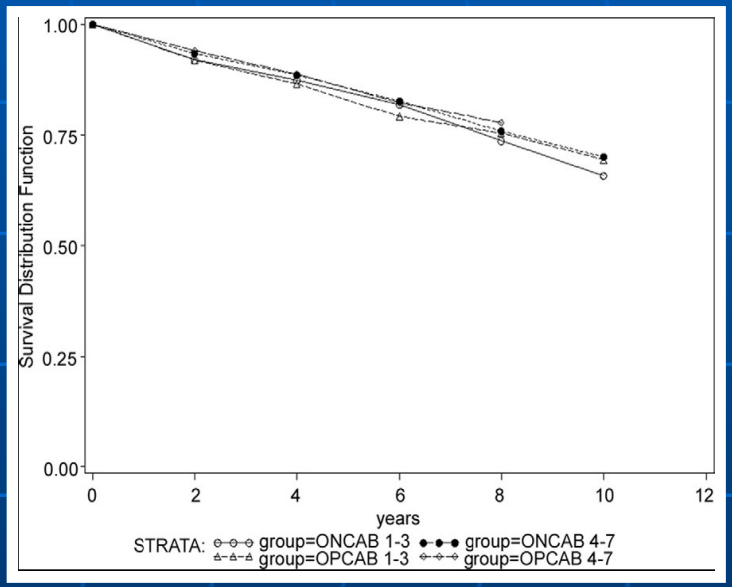
- ☑ Reduced **transfusions** and bleeding [2,4]
- ☑ Reduced **inotropes**[2,4]
- ☑ Reduced **arrhythmias**[2-4]
- ☑ Reduced **sternal wound infection**[2-4]
- ☑ Reduced **cerebral emboli** and cognitive dysfunction[3]
- ☑ Reduced **postoperative hospital length of stay**[2]

Influence of On-Pump Versus Off-Pump Techniques and Completeness of Revascularization on Long-Term Survival After Coronary Artery Bypass

Omar M. Lattouf, MD, PhD, Vinod H. Thourani, MD, Patrick D. Kilgo, MS, Michael E. Halkos, MD, Kim T. Baio, MSN, RN, Richard Myung, MD, William A. Cooper, MD, Robert A. Guyton, MD, and John D. Puskas, MD

(Ann Thorac Surg 2008;86:797–805)

- **12,812 consecutive pt's**
- **Ten-year survival data**
- **Four groups:**
  - **OPCABG 1 - 3 grafts (n = 3,946)**
  - **OPCABG 4 - 7 grafts (n = 1,721)**
  - **On-pump CABG 1 - 3 grafts (n = 3,380)**
  - **On-p**

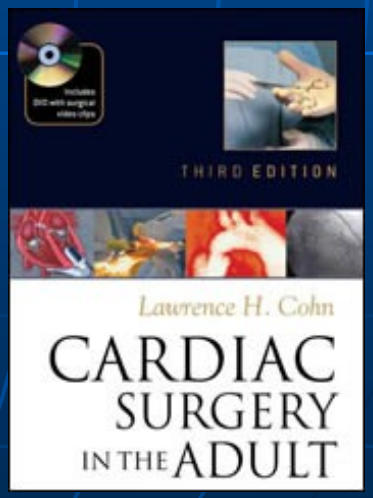


Conclusions. Long-term survival was similar for patients receiving 1 to 3 or 4 to 7 grafts by either on-pump or off-pump techniques. However, higher ICOR was associated with improved long- term survival within all groups.

ICOR - Index of Completeness of Revascularization

Patients Most Likely to Benefit from OPCAB

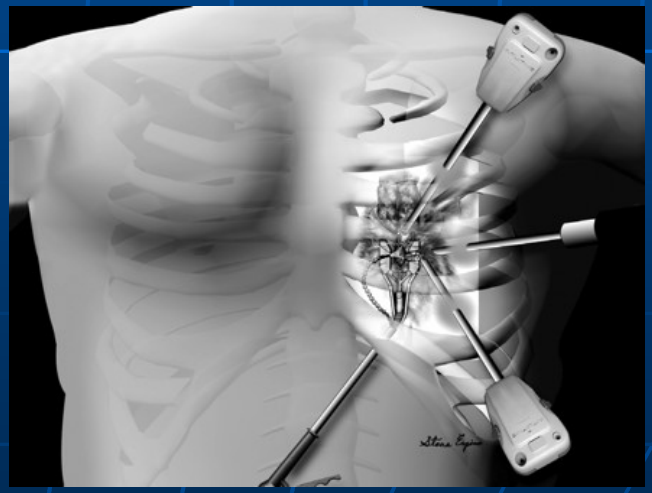
- Atheromatous calcified aorta
- Patients with significant comorbidities:
  - Cerebral vascular disease
  - Peripheral vascular disease
  - Hepatic disease
  - Bleeding disorders
  - COPD
  - Renal dysfunction
- Reoperative surgery
- Patients who refuse blood products



Minimally Invasive Myocardial Revascularization

- MINIMALLYINVASIVEDIRECT CORONARY ARTERY BYPASS **(MIDCAB)**

- TOTAL ENDOSCOPIC CORONARY ARTERY BYPASS GRAFTING **(TECAB)**



Results of graft patency by immediate angiography in minimally invasive coronary artery surgery

Michael J. Mack, James A. Magovern, Tea A. Acuff, Rodney J. Landreneau, Denise M. Tennison, Erin J. Tinnerman and John A. Osborne

Ann Thorac Surg 1999;68:383-389

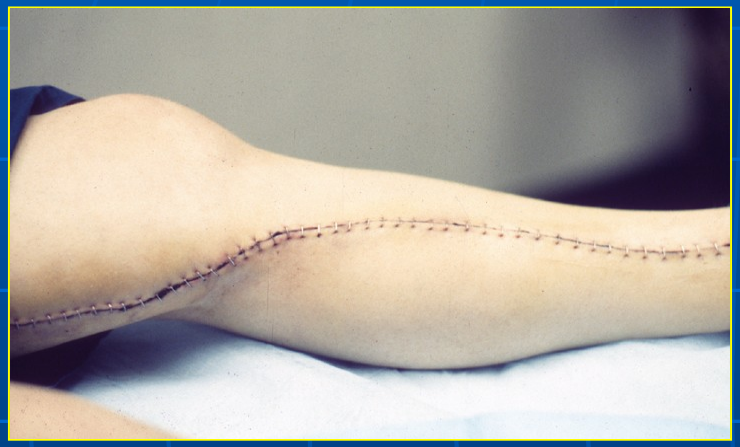
Table 2. Minimally Invasive Coronary Artery Bypass Procedures: Operative Data

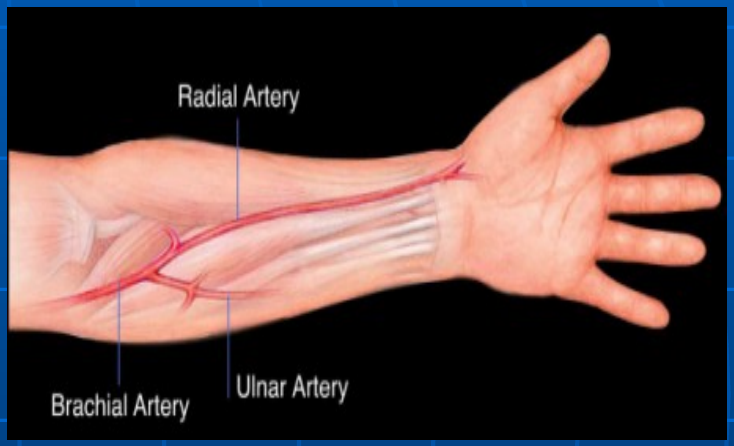
Operative Data	Number of Patients (n = 103)
Conversions	0
Operating time	139.85 ± 46.32 min
Internal mammary artery harvest time	32.63 ± 12.49 min
Anastomosis time	16.52 ± 5.00 min

Table 8. Published Series of Left Internal Mammary Artery Graft Patency in Minimally Invasive Coronary Artery Bypass

Author	Year	No. Studied/ Operated	Angio/ Operation	Interval Post-op Study	Graft Patency	Exclusions/Notes
Schaff [12]	1996	15/16	94%	intraoperative	100%	3 revised
Calafiore [13]	1996	53/155	34%	1–26 days	91%	
Subramanian [14]	1997	169/189	89%	24–36 h	92%	stenosis = occlusion
Gill [10]	1997	29/29	100%	4–6 h	97.5%	additional 19% stenosis > 50%
Current series	1998	100/103	97%	38 intraoperative 62 48–96 h	99%	additional 8% stenosis > 50%

Endoscopic Surgery





Endoscopic Saphenous Vein Harvesting

Complications (wound infection) was reduced significantly by **69%**

Cheng D, Allen K, Cohn W, et al: Endoscopic vascular harvest in coronary artery bypass grafting surgery : A meta-analysis of randomized trials and controlled trials. *Innovations* (in press).

Randomized trial of endoscopic versus open vein harvest for coronary artery bypass grafting: Six-month patency rates

J Thorac Cardiovasc Surg 2005;129:496-503

Follow-up angiography of all vein grafts - 6 .months after the operation

TABLE 5. Graft patency and disease according to vein harvest method

	EVH (n = 166)	OVH (n = 170)
Patent	113 (68%)	119 (70%)
Significant disease	17 (10%)	21 (12%)
Occlusion	36 (22%)	30 (18%)

P = .584. *EVH*, Endoscopic vein harvest; *OVH*, open vein harvest.

Endoscopic Radial Artery Harvesting may be the Procedure of Choice for Coronary Artery Bypass Grafting

Table 5 Radial Artery Graft Patency Assessed by MDCT at least 6 months after surgery

	Open group (n=18)	*Endoscopic group (n=76)*	*p value*
Radial artery	*17 (94.4%)*	*74 (97.4%)*	*0.476*
Left IMA	*17 (94.4%)*	*76 (100%)*	*0.191*
Saphenous vein	*16 (88.9%)*	*62 (82.7%)*	*0.727*

MDCT, multidetector computed tomography; IMA, internal mammary artery.

Circ J 2007; 71: 1511–1515

Robotics

The Da Vinci System

Visualization

Console

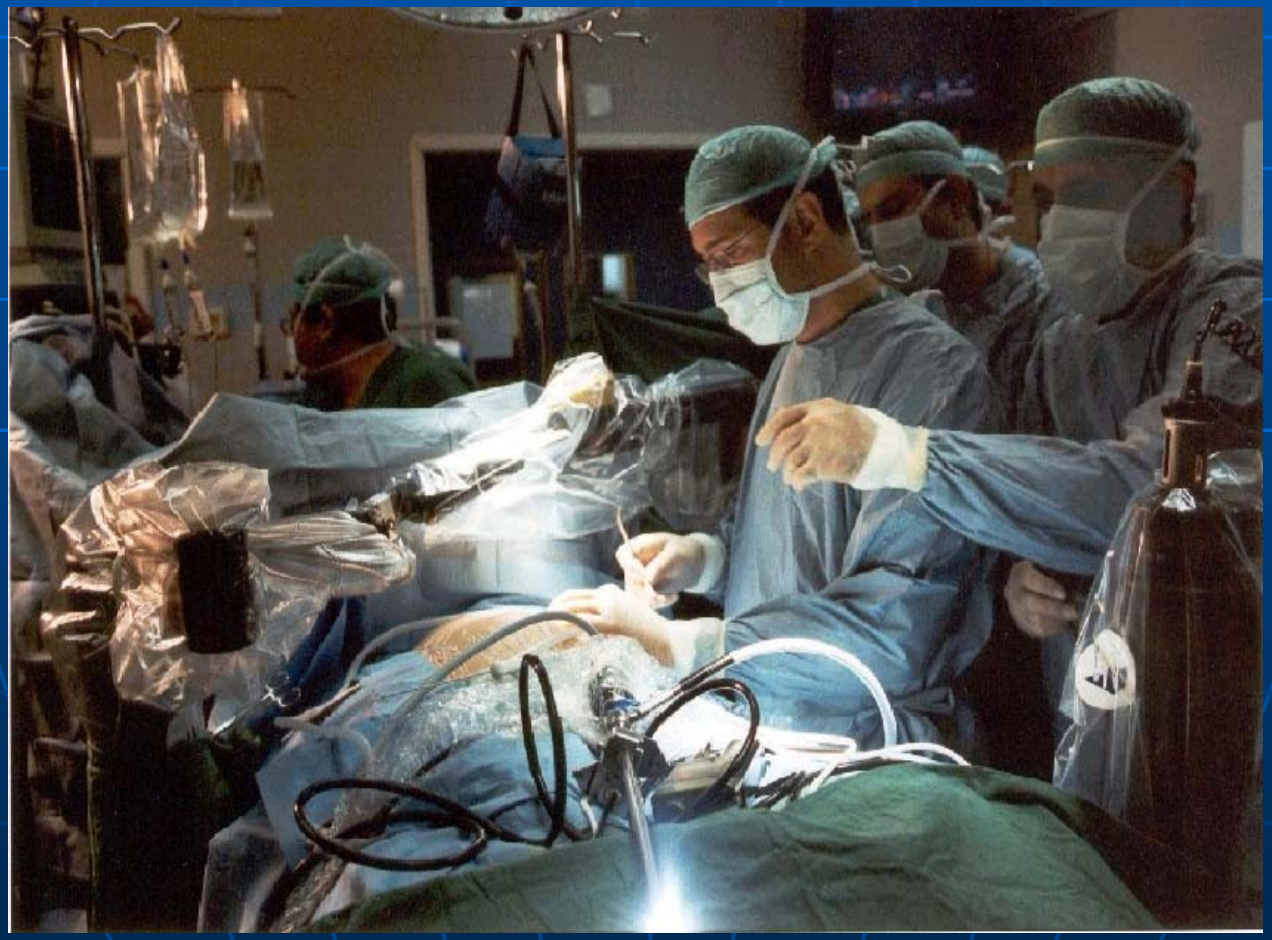
Stereo Visualization: Direct connection of surgeon hands to tool tips

Registration is both visual and spatial

Eye-hand coordination is restored

One image per eye

Addition of a 3 DOF wrist at the tip (total of 7 DOF)



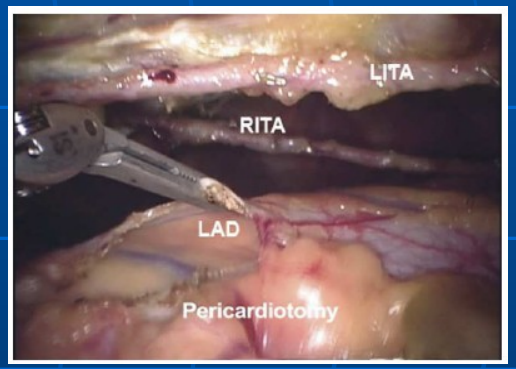
Use of Bilateral Internal Thoracic Arteries in CABG Through Lateral Thoracotomy With Robotic Assistance in 150 Patients

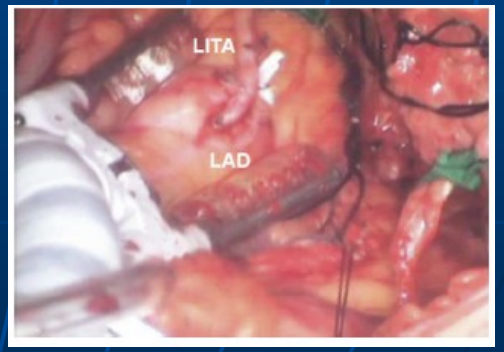
Sudhir Srivastava, MD, Suresh Gadasalli, MD, Madhava Agusala, MD, Ram Kolluru, MD, Jayaram Naidu, MD, Manish Shroff, MD, Reyna Barrera, PAC, Shaune Quismundo, RN, and Vishwa Srivastava, BA

Departments of Cardiovascular Surgery and Cardiology, Alliance Hospital, and Cardiac Surgical Associates, Odessa, Texas

Table 3. Postoperative Results

	Number of Patients
Bilateral internal thoracic artery revascularization	148/150 (99%)
Mortality	0
Conversion to cardiopulmonary bypass	0
Postoperative bleeding	5/150 (3.3%)
Myocardial infarction	0
Cerebrovascular accident	0
Respiratory failure	2/150 (1.3%)
Renal failure	4/150 (2.7%)
New onset atrial fibrillation	14/150 (9.3%)
Wound infection	0
Blood transfusion	19/150 (13%)





(Ann Thorac Surg 2006;81:800–6)

Hybrid Procedure

Hybrid Revascularization

- Lima to LAD followed by PCI to other targets- problem if PCI does not succeed
- PCI to CX and/or RCA territory followed by Minimally invasive LIMA to LAD- problem anti-platelets during surgery and PCI with significant LAD lesion

Simultaneous **integrated** coronary artery revascularization with long-term angiographic follow-up

- 58 pt's underwent simultaneous, integrated coronary artery revascularization in an operating theater equipped with angiographic equipment.
- CONCLUSION: For multivessel coronary artery disease, simultaneous integrated coronary artery revascularization with bivalirudin is **safe and feasible.**

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Thank you