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# On and Off – Pump CABG Risky Business

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# Disclosures

- Abbott: Surgical Co-PI of Momentum 3 Trial





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# On versus Off-Pump CABG - 2017

- On Pump CABG is the Gold Standard for Coronary Revascularization in 2017
- Goals of CABG
  - Palliation of Symptoms
  - Extend Life
  - Prevent Future Events – MI, death from CAD
- Avoiding Complications Associated with Cardiopulmonary Bypass became of interest in 1990's
  - Off Pump CABG proposed as a strategy to reduce complications

# Observational/Retrospective Data Comparing On and Off Pump CABG

## Off-Pump Coronary Artery Bypass Grafting Decreases Risk-Adjusted Mortality and Morbidity

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**Background.** The purpose of this study was to determine whether coronary artery bypass grafting without cardiopulmonary bypass (off-pump CABG) decreases risk-adjusted operative death and major complications after coronary artery bypass grafting in selected patients.

**Methods.** Using The Society of Thoracic Surgeons (STS) National Adult Cardiac Surgery Database, procedural outcomes were compared for conventional and off-pump CABG procedures from January 1, 1998, through December 31, 1999. Mortality and major complications were examined, both as unadjusted rates and after adjusting for known base line patient risk factors.

**Results.** A total of 126 experienced centers performed 118,140 total CABG procedures. The number of off-pump CABG cases was 11,717 cases (9.9% of total cases). The use of an off-pump procedure was associated with a

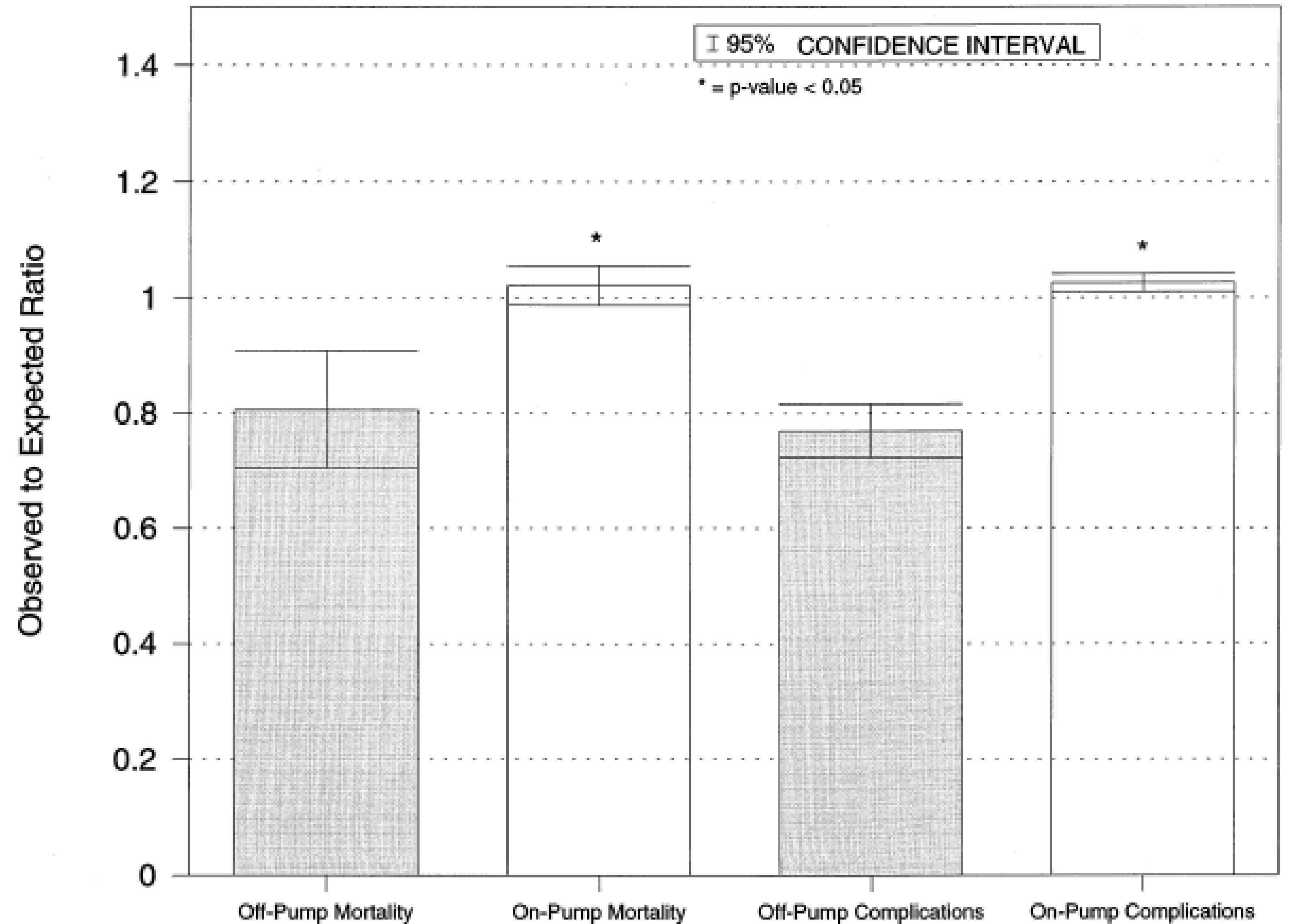
decrease in risk-adjusted operative mortality from 2.9% with conventional CABG to 2.3% in the off-pump group ( $p < 0.001$ ). The use of an off-pump procedure decreased the risk-adjusted major complication rate from 14.15% with conventional CABG to 10.62% in the off-pump group ( $p < 0.0001$ ). Patients receiving off-pump procedures were less likely to die (adjusted odds ratio 0.81, 95% CI 0.70 to 0.91) and less likely to have major complications (adjusted odds ratio 0.77, 95% CI 0.72 to 0.82).

**Conclusions.** Off-pump CABG is associated with decreased mortality and morbidity after coronary artery bypass grafting. Off-pump CABG may prove superior to conventional CABG in appropriately selected patients.

(Ann Thorac Surg 2001;72:1282-9)

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Fig 1. Observed-to-expected ratio of mortality and any major complication. Shown is the effect of off-pump CABG in decreasing observed-to-expected mortality and occurrence of any of the five major complications analyzed. (\*p < 0.05 between on-pump and off-pump groups.)



Trial	Risk	Year	Single v Multi-Institution	Outcome
GOPCABE	High (>75 yrs.)	2008-2011	Multi (12 German)	No Diff in Composite/More Revasc in Off
CORONARY	Average	2006-2011	Multi (19 Countries)	No Diff in Composite
BHACAS 1&2	Average	1997-1999	Single (UK)	No Diff in Patency/Survival/H RQOL
ROOBY (1 Yr.)	Average	2002-2008	Multiple (VA)	No Diff in Composite/Inferior Patency and Less Grafts Off Pump
ROOBY (5 Yr.)	Average	2002-2008	Multiple (VA)	Death and MACE lower in On Pump
DOORS	High (>70)	2005-2008	Multiple (Danish)	No Diff in Outcomes/lower patency - Off Pump
SMART	Average	2000-2001	Single (Emory)	No Difference in Patency, or Reintervention

# Off Pump Works Argument

ADULT CARDIAC

## Off-Pump and On-Pump Coronary Artery Bypass Grafting Are Associated With Similar Graft Patency, Myocardial Ischemia, and Freedom From Reintervention: Long-Term Follow-Up of a Randomized Trial

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# Survival at 5 Years is Better Off Pump

*Table 2. In-Hospital Major Adverse Cardiac Events Outcomes and Long-Term Survival*

Outcome	CABG on CPB (n = 99)	OPCAB (n = 98)	<i>p</i> Value
In-hospital death (%)	2 (2.0)	3 (3.1)	0.64
In-hospital stroke (%)	2 (2.0)	2 (2.0)	0.99
In-hospital MI (%)	0 (0.0)	0 (0.0)	1.00
In-hospital MACE (%) <sup>a</sup>	3 (3.0)	4 (4.1)	0.69
1-year survival (%)	95 (96.0)	95 (96.9)	0.71
3-year survival (%)	88 (88.9)	94 (95.9)	0.06
5-year survival (%)	81 (81.8)	91 (92.9)	0.02
7-year survival (%)	73 (73.7)	82 (83.7)	0.09

<sup>a</sup> MACE is defined as death + stroke + MI.

CABG = coronary artery bypass grafting; CPB = cardiopulmonary bypass; MACE = major adverse cardiac events; MI = myocardial infarction; OPCAB = off-pump coronary artery bypass grafting.

# Graft Patency Similar Early and Late

Table 3. Graft Patency by Target Vessel and Surgery Type: Early (In-Hospital), Intermediate (1-Year), and Late (8-Year) Arterial and Venous Graft Patency by Coronary Arterial Target<sup>a</sup>

Target Vessel	Grafts With Fitzgibbon A or B Score/Total Grafts Scored (%)			
	Arterial Conduits (n = 250)		Venous Conduits (n = 372)	
	OPCAB	CPB	OPCAB	CPB
LAD and branches (n = 273)				
Early	90/90 (100.0)	90/90 (100.0)	46/48 (95.8)	45/45 (100.0)
1-Year	69/71 (97.2)	76/77 (98.7)	34/36 (94.4)	35/35 (100.0)
8-Year	20/25 (80.0)	23/27 (85.2)	13/14 (92.9)	8/9 (88.9)
RCA and branches (n = 168)				
Early	14/14 (100.0)	12/13 (92.3)	68/68 (100.0)	69/73 (94.5)
1-Year	11/13 (84.6)	10/10 (100.0)	54/56 (96.4)	55/60 (91.7)
8-Year	4/4 (100.0)	3/6 (50.0)	21/26 (80.8)	14/16 (87.5)
LCx and branches (n = 181)				
Early	22/22 (100.0)	21/21 (100.0)	71/72 (98.6)	64/66 (97.0)
1-Year	15/17 (88.2)	16/17 (94.1)	52/58 (89.7)	57/61 (93.4)
8-Year	5/10 (50.0)	7/9 (77.8)	13/18 (72.2)	21/23 (91.3)
All coronary arteries (n = 622)				
Early	126/126 (100.0)	123/124 (99.2)	185/188 (98.4)	178/184 (96.7)
1-Year	95/101 (94.1)	102/104 (98.1)	140/150 (93.3)	147/156 (94.2)
8-Year	29/39 (74.4)	33/42 (78.6)	47/58 (87.0)	43/48 (90.0)

<sup>a</sup> All comparisons between OPCAB and CPB are not significant at all time points.

CPB = cardiopulmonary bypass; LAD = left anterior descending coronary artery; LCx = left circumflex artery; OPCAB = off-pump coronary artery bypass grafting; RCA = right coronary artery.



**Conclusion: John Puskas is a superb on and off pump CABG surgeon**

# Is Off Pump for Everyone?

The NEW ENGLAND JOURNAL of MEDICINE

ORIGINAL ARTICLE

## Five-Year Outcomes after On-Pump and Off-Pump Coronary-Artery Bypass

A. Laurie Shroyer, Ph.D., Brack Hattler, M.D., Todd H. Wagner, Ph.D., Joseph F. Collins, Sc.D., Janet H. Baltz, R.N., Jacquelyn A. Quin, M.D., G. Hossein Almassi, M.D., Elizabeth Kozora, Ph.D., Faisal Bakaeen, M.D., Joseph C. Cleveland, Jr., M.D., Muath Bishawi, M.D., and Frederick L. Grover, M.D., for the Veterans Affairs ROOBY-FS Group\*

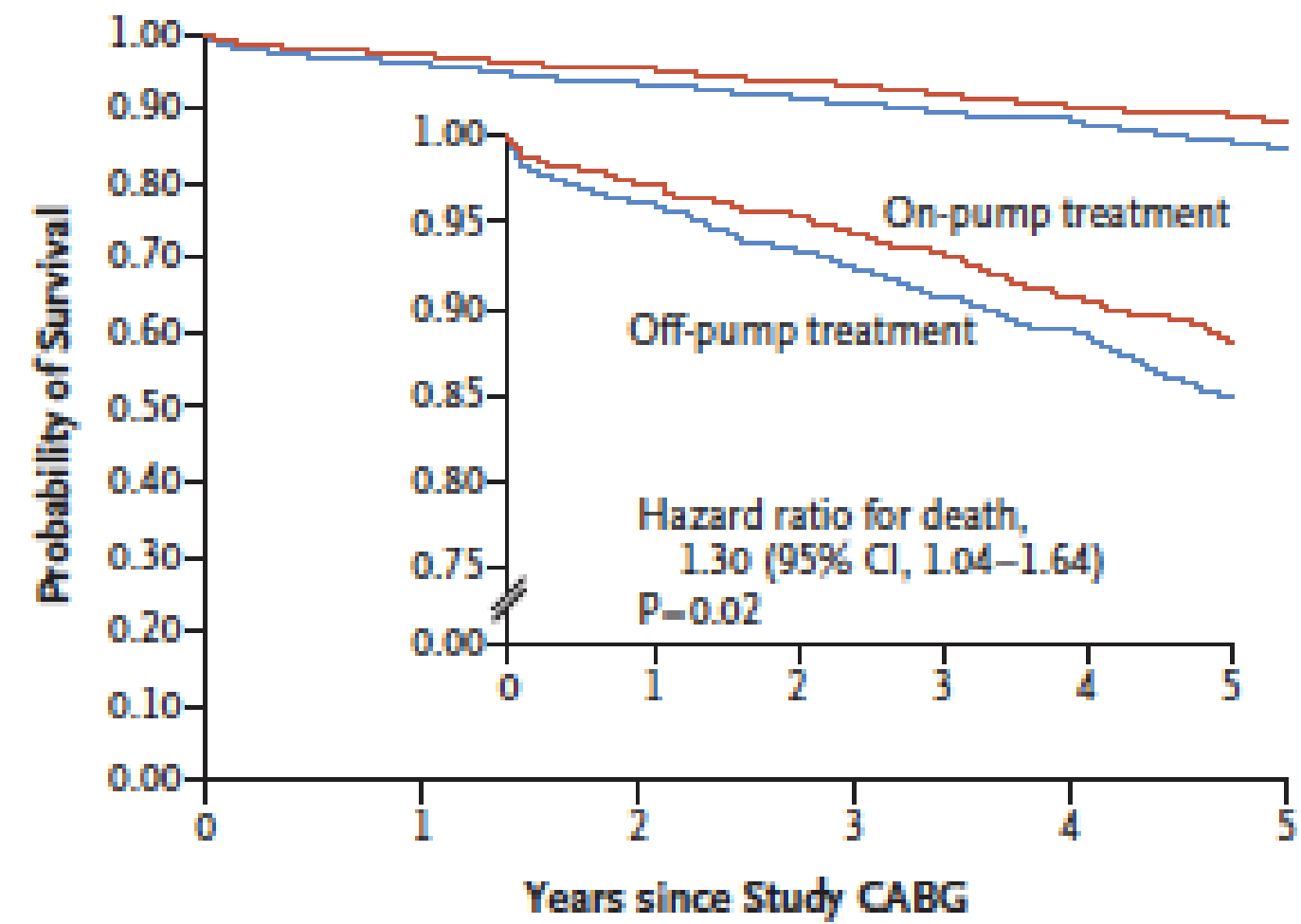
ABSTRACT

### BACKGROUND

Coronary-artery bypass grafting (CABG) surgery may be performed either with cardiopulmonary bypass (on pump) or without cardiopulmonary bypass (off pump). We report the 5-year clinical outcomes in patients who had been included in the Veterans Affairs trial of on-pump versus off-pump CABG.

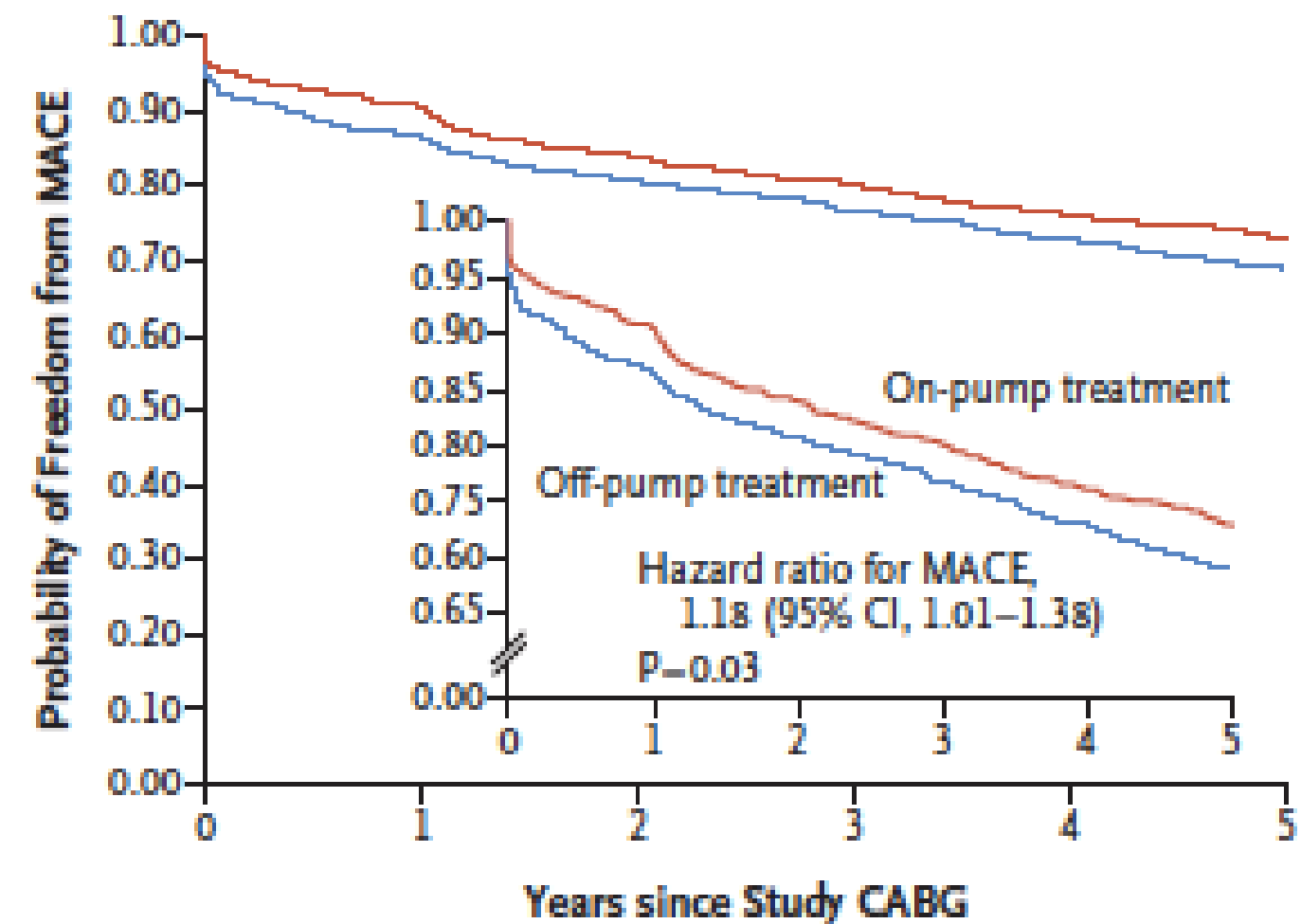


**A Survival**



No. at Risk	0	1	2	3	4	5
On-pump treatment	1099	1069	1049	1024	993	968
Off-pump treatment	1104	1061	1031	1000	976	936

**B Freedom from MACE**



No. at Risk	0	1	2	3	4	5
On-pump treatment	1099	994	923	881	836	801
Off-pump treatment	1104	955	890	847	805	762

# ROOBY Trial

- “ Across all 5 – year clinical outcomes that were evaluated, the off-pump approach did not confer any advantage over on-pump CABG procedures”
- Criticisms of this trial
  - VA centers only. However, these VA centers were affiliated and included surgeons from NYU, Duke, University of Florida, Stanford, University of Colorado
  - Residents were allowed to do cases. In separate analysis, Resident v Attending had no effect upon patency of grafts
  - Surgeons were inexperienced in off – pump CABG. Legitimate of all criticisms, but what is the magic number?



# Surgeons Vote with Their Technique

## ACQUIRED CARDIOVASCULAR DISEASE

### Trends in use of off-pump coronary artery bypass grafting: Results from the Society of Thoracic Surgeons Adult Cardiac Surgery Database

Faisal G. Bakaeen, MD,<sup>a,b</sup> A. Laurie W. Shroyer, PhD,<sup>c</sup> James S. Gammie, MD,<sup>d</sup> Joseph F. Sabik, MD,<sup>e</sup> Lorraine D. Comwell, MD,<sup>a</sup> Joseph S. Coselli, MD,<sup>a,b</sup> Todd K. Rosengart, MD,<sup>a,b</sup> Sean M. O'Brien, PhD,<sup>f</sup> Amelia Wallace, BSPH,<sup>f</sup> David M. Shahian, MD,<sup>g</sup> Frederick L. Grover, MD,<sup>h</sup> and John D. Puskas, MD<sup>i</sup>

**Objectives:** Recent national trends in off-pump versus on-pump coronary artery bypass grafting have not been reported.

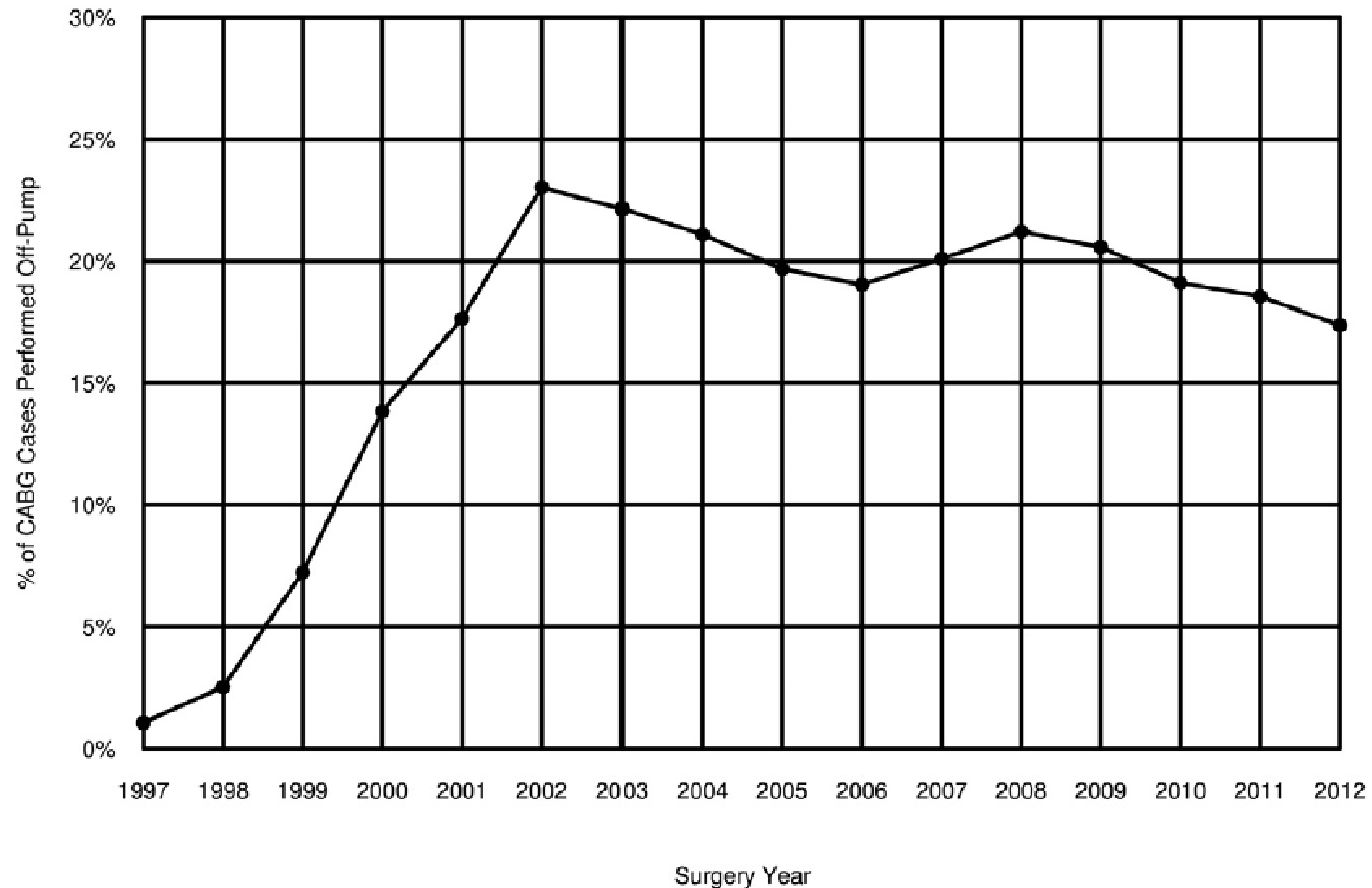
**Methods:** We analyzed data from the Society of Thoracic Surgeons Adult Cardiac Surgery Database regarding isolated primary coronary artery bypass grafting operations (N = 2,137,841; 1997-2012). The off-pump percentages were calculated in aggregate, by center, and by surgeon. On the basis of the 2007/2008 yearly off-pump volume, the analysis subgroups were "high" (center n > 200, surgeon n > 100), "intermediate" (center n = 50-200, surgeon n = 20-100), and "low" (center n = 1-49, surgeon n = 1-19).

**Results:** The use of off-pump procedures peaked in 2002 (23%) and again in 2008 (21%), followed by a progressive decline in off-pump frequency to 17% by 2012. After 2008, off-pump rates declined among both high-volume and intermediate-volume centers and surgeons; little change was observed for low-volume centers or surgeons (off-pump rates = 10% since 2008). By the end of the study period, 84% of centers performed fewer than 50 off-pump cases per year, 34% of surgeons performed no off-pump operations, and 86% of surgeons performed fewer than 20 off-pump cases per year. Except for a higher (7.8%) conversion rate in 2003, the rate for conversions fluctuated approximately 6%.

**Conclusions:** Enthusiasm for off-pump coronary artery bypass grafting has been tempered. The percentage of coronary artery bypass grafting operations performed off-pump has steadily declined over the last 5 years, and currently this technique is used in fewer than 1 in 5 patients who undergo surgical coronary revascularization. A minority of surgeons and centers continue to perform off-pump coronary artery bypass grafting in most of their patients. (J Thorac Cardiovasc Surg 2014;148:856-64)

ACD

# Less than 1/5 Patients in North America have CABG done Off-Pump





# Conclusions

- I remain an on-pump CABG surgeon
- I will selectively use an off-pump CABG for
  - Extensive Calcification/atherosclerosis of ascending aorta
  - LIMA to LAD when co-morbid conditions are present
- There is a role for off-pump CABG



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# Gracias



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