Improved CABG for Complex CAD: A Perspective of “Coming Back”

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

Professor of Cardiothoracic Surgery, Icahn School of Medicine at Mount Sinai
Chairman, Department of Cardiac Surgery, Mount Sinai Beth Israel
Director, Surgical Coronary Revascularization, Mount Sinai Health System

New York Cardiovascular Society
New York, New York
December 14, 2014
Disclosures/Conflicts

- The author is a practicing cardiac surgeon.
- Royalties from coronary surgical instruments invented by the author and marketed by Scanlan, Inc.
- No other relevant financial COI’s.
Improved CABG for Complex CAD

- CABG is associated with better outcomes than PCI for most patients with complex CAD, especially diabetics: SYNTAX and FREEDOM
- BITA grafting prolongs life
- Radial Arteries are (usually) better than veins
- OPCAB can be better than ONCAB, but requires special expertise
- Clampless OPCAB, by avoiding/minimizing manipulation of the ascending aorta, is associated with lower risk of stroke
- All-arterial, clampless OPCAB is state-of-the-art CABG
- Hybrid Coronary Revascularization may offer unique advantages to selected patient subsets
**MACCE to 5 Years**

- **CABG (N=897)**
- **TAXUS (N=903)**

<table>
<thead>
<tr>
<th>Time Period</th>
<th>CABG Event Rate</th>
<th>TAXUS Event Rate</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before 1 year*</td>
<td>12.4% vs 17.8%</td>
<td>17.8% vs 12.4%</td>
<td>P=0.002</td>
</tr>
<tr>
<td>1–2 years*</td>
<td>5.7% vs 8.3%</td>
<td>8.3% vs 5.7%</td>
<td>P=0.03</td>
</tr>
<tr>
<td>2–3 years*</td>
<td>4.8% vs 6.7%</td>
<td>6.7% vs 4.8%</td>
<td>P=0.10</td>
</tr>
<tr>
<td>3–4 years*</td>
<td>4.2% vs 7.9%</td>
<td>7.9% vs 4.2%</td>
<td>P=0.002</td>
</tr>
<tr>
<td>4–5 years*</td>
<td>5.0% vs 6.3%</td>
<td>6.3% vs 5.0%</td>
<td>P=0.27</td>
</tr>
</tbody>
</table>

**P<0.001**

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

ITT population
MACCE to 5 Years by SYNTAX Score Tercile *Low Scores (0–22)*

**Overall**

<table>
<thead>
<tr>
<th>Event</th>
<th>CABG</th>
<th>PCI</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Death</td>
<td>10.1%</td>
<td>8.9%</td>
<td>0.64</td>
</tr>
<tr>
<td>CVA</td>
<td>4.0%</td>
<td>1.8%</td>
<td>0.11</td>
</tr>
<tr>
<td>MI</td>
<td>4.2%</td>
<td>7.8%</td>
<td>0.11</td>
</tr>
<tr>
<td>Death, CVA or MI</td>
<td>14.9%</td>
<td>16.1%</td>
<td>0.81</td>
</tr>
<tr>
<td>Revasc.</td>
<td>16.9%</td>
<td>23.0%</td>
<td>0.06</td>
</tr>
</tbody>
</table>

*Cumulative KM Event Rate ± 1.5 SE; log-rank P value*
MACCE to 5 Years by SYNTAX Score Tercile *Intermediate Scores (23–32)*

**CABG (N=300)**

**TAXUS (N=310)**

<table>
<thead>
<tr>
<th>Event</th>
<th>CABG (%)</th>
<th>PCI (%)</th>
<th><em>P</em> value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Death</td>
<td>12.7%</td>
<td>13.8%</td>
<td>0.68</td>
</tr>
<tr>
<td>CVA</td>
<td>3.6%</td>
<td>2.0%</td>
<td>0.25</td>
</tr>
<tr>
<td>MI</td>
<td>3.6%</td>
<td>11.2%</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Death, CVA or MI</td>
<td>18.0%</td>
<td>20.7%</td>
<td>0.42</td>
</tr>
<tr>
<td>Revasc.</td>
<td>12.7%</td>
<td>24.1%</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

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

Core lab–reported Data; ITT population
MACCE to 5 Years by SYNTAX Score

Tercile *High Scores* \( \geq 33 \)

<table>
<thead>
<tr>
<th></th>
<th>CABG (N=315)</th>
<th>PCI</th>
<th><em>P</em> value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Death</td>
<td>11.4%</td>
<td>19.2%</td>
<td>0.005</td>
</tr>
<tr>
<td>CVA</td>
<td>3.7%</td>
<td>3.5%</td>
<td>0.80</td>
</tr>
<tr>
<td>MI</td>
<td>3.9%</td>
<td>10.1%</td>
<td>0.004</td>
</tr>
<tr>
<td>Death, CVA or MI</td>
<td>17.1%</td>
<td>26.1%</td>
<td>0.007</td>
</tr>
<tr>
<td>Revasc.</td>
<td>12.1%</td>
<td>30.9%</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

Core lab–reported Data; ITT population

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

SYNTAX 5-year Outcomes • ESC 2012 • Mohr • August 2012 • Slide 7
Eligibility: DM pts with MV-CAD eligible for stent or surgery

Exclude: Patients with acute STEMI

Randomized 1:1
N=1900

MV-Stenting With Drug-eluting

CABG With or Without CPB

All concomitant Meds shown to be beneficial were encouraged, including: clopidogrel, ACE inhib., ARBs, b-blockers, statins
**PRIMARY OUTCOME – DEATH / STROKE / MI**

- **PCI/DES**
- **CABG**

Logrank P=0.005

5-Year Event Rates: 26.6% vs. 18.7%

<table>
<thead>
<tr>
<th>Years post-randomization</th>
<th>PCI/DES N</th>
<th>CABG N</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>953</td>
<td>943</td>
</tr>
<tr>
<td>1</td>
<td>848</td>
<td>814</td>
</tr>
<tr>
<td>2</td>
<td>788</td>
<td>758</td>
</tr>
<tr>
<td>3</td>
<td>625</td>
<td>613</td>
</tr>
<tr>
<td>4</td>
<td>416</td>
<td>422</td>
</tr>
<tr>
<td>5</td>
<td>219</td>
<td>221</td>
</tr>
<tr>
<td>6</td>
<td>40</td>
<td>44</td>
</tr>
</tbody>
</table>
PRIMARY ENDPOINT – DEATH / STROKE / MI
TREATMENT / SYNTAX INTERACTION - p=0.58

SYNTAX Score ≤ 22
(N=669)

5-Year Event Rates:
23.2%
17.2%

SYNTAX Score 23-32
(N=844)

5-Year Event Rates:
27.2%
17.7%

SYNTAX Score ≥ 33
(N=374)

5-Year Event Rates:
30.6%
22.8%
**ALL-CAUSE MORTALITY**

Logrank

\[ P=0.049 \]

5-Year Event Rates: 16.3% vs. 10.9%

<table>
<thead>
<tr>
<th>PCI/DES N</th>
<th>953</th>
<th>897</th>
<th>845</th>
<th>685</th>
<th>466</th>
<th>243</th>
</tr>
</thead>
<tbody>
<tr>
<td>CABG N</td>
<td>947</td>
<td>855</td>
<td>806</td>
<td>655</td>
<td>449</td>
<td>238</td>
</tr>
</tbody>
</table>

Years post-randomization
MYOCARDIAL INFARCTION

Myocardial Infarction, %

Logrank P<0.0001

PCI/DES

CABG

PCI/DES N 953

CABG N 947

Years post-randomization

0 1 2 3 4 5

0 10 20 30

13.9 %

6.0 %
STROKE

### Severe Disabling Scale

<table>
<thead>
<tr>
<th>Scale</th>
<th>CABG</th>
<th>PCI/DES</th>
</tr>
</thead>
<tbody>
<tr>
<td>NIH &gt; 4</td>
<td>55%</td>
<td>27%</td>
</tr>
<tr>
<td>Rankin &gt;1</td>
<td>70%</td>
<td>60%</td>
</tr>
</tbody>
</table>

**Logrank P = 0.034**

- **PCI/DES N**: 953, 891, 833, 673, 460, 241
- **CABG N**: 947, 844, 791, 640, 439, 230
Conclusion

• In patients with diabetes and advanced coronary disease, **CABG was of significant benefit as compared to PCI.** MI & all cause mortality were independently decreased, while stroke was slightly increased.

• There was **no significant interaction** between the treatment effect of CABG on the primary endpoint according to **SYNTAX score or any other prespecified subgroup**.

• **CABG surgery is the preferred method of revascularization for patients with diabetes & multi-vessel CAD.**
2011 ACCF/AHA Guidelines for Coronary Artery Bypass Graft Surgery

John D. Puskas, MD, FACS, FACC
Emory University

On Behalf of the 2011 CABG Guidelines Writing Committee

American Heart Association Scientific Sessions 2011
Orlando, FL

Developed in Collaboration with and endorsed by the American Association for Thoracic Surgery, Society of Cardiovascular Anesthesiologists, and Society for Thoracic Surgeons
It is reasonable to choose CABG over PCI to improve survival in patients with complex 3-vessel CAD (e.g., SYNTAX score >22) with or without involvement of the proximal LAD artery who are good candidates for CABG.
CABG is probably recommended in preference to PCI to improve survival in patients with multivessel CAD and diabetes mellitus, particularly if a LIMA graft can be anastomosed to the LAD artery.
Bypass Graft Conduits

When anatomically and clinically suitable, use of a second IMA to graft the left circumflex or right coronary artery (when critically stenosed and perfusing LV myocardium) is reasonable to improve the likelihood of survival and to decrease reintervention.

Complete arterial revascularization may be reasonable in patients ≤60 years of age with few or no comorbidities.
## Procedural aspects of CABG

<table>
<thead>
<tr>
<th>Recommendations</th>
<th>Class</th>
<th>Level</th>
<th>Ref.</th>
</tr>
</thead>
<tbody>
<tr>
<td>It is recommended to perform procedures in a hospital structure and by a team</td>
<td>I</td>
<td>B</td>
<td>635,636</td>
</tr>
<tr>
<td>specialized in cardiac surgery, using written protocols.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Endoscopic vein harvesting should be considered to reduce the incidence of</td>
<td>IIa</td>
<td>A</td>
<td>577,578,580–582, 637,638</td>
</tr>
<tr>
<td>leg wound complications.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Routine skeletonized IMA dissection should be considered.</td>
<td>IIa</td>
<td>B</td>
<td>586–589</td>
</tr>
<tr>
<td>Skeletonized IMA dissection is recommended in patients with diabetes or when</td>
<td>I</td>
<td>B</td>
<td>586–589</td>
</tr>
<tr>
<td>bilateral IMAs are harvested.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Complete myocardial revascularization is recommended.</td>
<td>I</td>
<td>B</td>
<td>594,598,600</td>
</tr>
<tr>
<td>Arterial grafting with IMA to the LAD system is recommended.</td>
<td>I</td>
<td>B</td>
<td>602,603,639</td>
</tr>
<tr>
<td>Bilateral IMA grafting should be considered in patients &lt;70 years of age.</td>
<td>IIa</td>
<td>B</td>
<td>165,606–610,640, 641</td>
</tr>
<tr>
<td>Use of the radial artery is recommended only for target vessels with high-degree</td>
<td>I</td>
<td>B</td>
<td>618,642</td>
</tr>
<tr>
<td>stenosis.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total arterial revascularization is recommended in patients with poor</td>
<td>I</td>
<td>C</td>
<td>-</td>
</tr>
<tr>
<td>vein quality independently of age.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total arterial revascularization should be considered in patients with</td>
<td>IIa</td>
<td>B</td>
<td>643</td>
</tr>
<tr>
<td>reasonable life expectancy.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minimization of aortic manipulation is recommended.</td>
<td>I</td>
<td>B</td>
<td>442,644</td>
</tr>
<tr>
<td>Off-pump CABG should be considered for subgroups of high-risk patients in</td>
<td>IIa</td>
<td>B</td>
<td>626,627,629</td>
</tr>
<tr>
<td>high-volume off-pump centres.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Off-pump CABG and/or no-touch on-pump techniques on the ascending aorta are</td>
<td>I</td>
<td>B</td>
<td>443</td>
</tr>
<tr>
<td>recommended in patients with significant atherosclerotic disease of the</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ascending aorta in order to prevent perioperative stroke.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minimally invasive CABG should be considered in patients with isolated LAD</td>
<td>IIa</td>
<td>C</td>
<td>-</td>
</tr>
<tr>
<td>lesions.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electrocardiogram-triggered CT scans or epiaortic scanning of the ascending</td>
<td>IIa</td>
<td>C</td>
<td>-</td>
</tr>
<tr>
<td>aorta should be considered in patients over 70 years of age and/or with signs</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>of extensive generalized atherosclerosis.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Routine intraoperative graft flow measurement should be considered.</td>
<td>IIa</td>
<td>C</td>
<td>-</td>
</tr>
</tbody>
</table>
"Why Did You Not Use Both Internal Thoracic Arteries?"
John D. Puskas

Circulation. published online November 19, 2012;
Circulation is published by the American Heart Association, 7272 Greenville Avenue, Dallas, TX 75231
Copyright © 2012 American Heart Association, Inc. All rights reserved.
Print ISSN: 0009-7322. Online ISSN: 1524-4539
“Two Better Than One” - BITA

A Meta-analysis of Adjusted Hazard Ratios from 20 Observational Studies of Bilateral Versus Single Internal Thoracic Artery Coronary Artery Bypass Grafting

- 20 observational studies; 70,897 patients, pooled analysis
- BITA associated with significant reduction in long-term mortality relative to SITA (HR 0.80; 95% CI 0.77-0.84)
- Benefit of BITA increased in studies with higher proportions of males
1.2.1 Pedicled ITA

Buxton 1998
-0.3415 0.1256 1269 1557 5.8% 0.71 [0.56, 0.91]
Carrier 2009, statin (+)
-0.0781 0.1562 1166 4835 3.8% 0.92 [0.68, 1.26]
Carrier 2009, statin (-)
-0.4368 0.1197 69 585 6.4% 0.65 [0.51, 0.82]
Grau 2012
-0.3955 0.1126 928 928 7.3% 0.67 [0.54, 0.84]
Kelly 2012
-0.2008 0.1004 1079 6554 9.1% 0.82 [0.67, 1.00]
Pick 1997
-0.2002 0.2489 160 161 1.5% 0.82 [0.50, 1.33]
Stevens 2004
-0.3081 0.1034 1808 2498 8.6% 0.73 [0.60, 0.90]
Subtotal (95% CI)
6479 17118 42.5% 0.74 [0.68, 0.81]

Heterogeneity: Chi² = 5.30, df = 6 (P = 0.51); I² = 0%
Test for overall effect: Z = 6.44 (P < 0.00001)

1.2.2 Skeletonized ITA

Bonacchi 2006
-0.4055 0.6551 320 332 0.2% 0.67 [0.18, 2.41]
Endo 2001
-0.0502 0.1787 443 688 2.9% 0.95 [0.67, 1.35]
Joo 2012
-0.0125 0.2222 366 366 1.9% 0.99 [0.64, 1.53]
Kinoshita 2012
-0.5906 0.2962 217 217 1.0% 0.55 [0.31, 0.99]
Kurlansky 2010
-0.1778 0.0426 2215 2369 50.7% 0.84 [0.77, 0.91]
Navia 2013
-0.0194 0.343 149 149 0.8% 0.98 [0.50, 1.92]
Subtotal (95% CI)
3710 4121 57.5% 0.84 [0.78, 0.91]

Heterogeneity: Chi² = 3.32, df = 5 (P = 0.65); I² = 0%
Test for overall effect: Z = 4.31 (P < 0.00001)

Total (95% CI)
10189 21239 100.0% 0.80 [0.75, 0.85]

Heterogeneity: Chi² = 12.94, df = 12 (P = 0.37); I² = 7%
Test for overall effect: Z = 7.47 (P < 0.00001)
Test for subgroup differences: Chi² = 4.32, df = 1 (P = 0.04), I² = 76.9%
Bilateral Internal Thoracic Artery Grafting Is Associated with Significantly Improved Long-Term Survival, Even Among Diabetic Patients

John D. Puskas, MD; Adil Sadiq, MS, MCh; Thomas A. Vassilisades, MD; Patrick D. Kilgo*, MS; Omar M. Lattouf, MD, PhD

Clinical Research Unit, Division of CT Surgery, Emory University

Society of Thoracic Surgeons Annual Meeting
January 30, 2012
Fort Lauderdale, FL
Subjects and Sample:

- 1/12002 -- 12/31/2010, study cohort: 3,527 isolated primary CABG patients performed by 3 Emory surgeons interested in BITA grafting.
- These surgeons did 9.8% to 37.3% of cases with BITA.
Results: Death, Stroke or MI

- There were no significant differences in 30-day death, stroke or MI among non-DM patients who had BITA vs. SITA, nor among DM patients who had BITA vs. SITA.
BITA Improves Risk-Adjusted LT Survival

- Importantly, BITA grafting conferred a 35% reduction (95% CI 12%-52%, \( p=0.006 \)) in risk-adjusted long-term hazard of death.

- This benefit was equal for non-DM and DM patients (\( p=0.93 \)).
**Survival Analysis**

**Patients at Risk**

<table>
<thead>
<tr>
<th></th>
<th>0 yr</th>
<th>1 yr</th>
<th>3 yr</th>
<th>5 yr</th>
<th>8 yr</th>
</tr>
</thead>
<tbody>
<tr>
<td>SITA NON-DIABETES</td>
<td>1461</td>
<td>1389</td>
<td>1322</td>
<td>1230</td>
<td>1076</td>
</tr>
<tr>
<td>BITA NON-DIABETES</td>
<td>557</td>
<td>545</td>
<td>535</td>
<td>520</td>
<td>503</td>
</tr>
<tr>
<td>SITA DIABETES</td>
<td>1156</td>
<td>1085</td>
<td>991</td>
<td>901</td>
<td>701</td>
</tr>
<tr>
<td>BITA DIABETES</td>
<td>220</td>
<td>217</td>
<td>209</td>
<td>192</td>
<td>192</td>
</tr>
</tbody>
</table>
Results: DSWI

- Overall, deep sternal wound infection (DSWI) was more common among DM, than among non-DM patients (1.5% vs. 0.7%; p=0.02).
- Overall, BITA patients had similar DSWI rates compared to SITA (1.2% vs. 1.0%).
- DSWI was similar within non-DM (1.0% vs. 0.6%) and within DM patients (1.7% vs. 1.5%) who had BITA vs. SITA.
- Patients with DSWI had higher HbA1c (7.6% vs 6.5%; p=0.01)
Conclusion (1):

- BITA grafting confers a long-term survival advantage and should be performed whenever suitable coronary anatomy exists and patient risk factors allow an acceptable risk of DSWI.
Surgical Revascularization Techniques That Minimize Surgical Risk and Maximize Late Survival After Coronary Artery Bypass Grafting in Patients with Diabetes Mellitus
Raza et al. JTCVS 2014;148:1257-66

- 1972-2011, 11,922 patients with DM had isolated CABG
- Adjusted risk of late mortality 21% lower with BITA vs SITA
- BITA assoc. with increased DSWI (risk factors: female, obese, prior MI, PVD, medically treated DM)
- OPCAB vs ONCAB statistically similar results
- Complete vs incomplete revascularization had similar in-hospital outcomes; complete revasc associated with 10% lower late mortality
- BITA grafting with complete revascularization maximizes long-term survival in diabetic patients undergoing CABG
- Avoid in obese diabetic women with diffuse PVD—highest DSWI
“We identified BITA plus complete revascularization plus off-pump CABG as the strategy with the best predicted survival, and no ITA grafts plus incomplete revascularization plus on-pump CABG with the worst.”

“We found that patients deriving the greatest survival benefit (greater than a 23% 10-year survival difference) from the best surgical combination were actually the sickest of all—older women undergoing emergency surgery, with higher bilirubin, previous stroke, PVD and IDDM”
The Right Internal Thoracic Artery: The Forgotten Conduit—5,766 Patients and 991 Angiograms

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

Departments of Cardiothoracic Surgery, Royal Melbourne Hospital, Epworth Hospital, and University of Melbourne, Melbourne, Australia
Total Arterial Revascularization with Internal Thoracic and Radial Artery Grafts in Triple-Vessel Coronary Artery Disease is Associated with Improved Survival
Buxton et al JTCVS 2014;148:1238-44

- 1995-2010, 6059 patients with 3VD had primary isolated CABG at 8 centers (all Univ Melbourne, Australia) in a multicenter prospective database
- Study cohort of TAR (n=2988) versus SITA + SVG (n=786), yielding 384 propensity matched pairs with up to 15 years follow-up
At 15 years:

- TAR: 54 ± 3.3%
- SITA + SV: 41 ± 3.0%

p = 0.0004
Secondary analysis of the RAPS, a longitudinal, multicenter RCT (Canada)

- Inclusion: age < 80, LVEF > 35%, 3VD undergoing nonemergency isolated CABG
- Targets: native stenosis in all targets >70%, diameter >1.5mm
- Within-patient randomization whereby the RA was randomized to the inferior (RCA) or lateral (LCx) region versus the SVG; LIMA-LAD routine; 529 patients randomized
- Open harvest of RA and SVG; Angio > 5yrs postop

- 83/269 (30.9%) of those who had FU angio (mean 7.7 years postop) had DM
- Graft occlusion significantly lower in RA grafts (4/83, 4.8%) versus SVG (21/83, 25.3%; p=0.0004)
- Similar patency findings in non-diabetic patients
- MV models showed RA and tight native stenosis favored patency, while female gender, smoking and CRF were associated with increased risk.
BITA Grafting: The Most Effective Therapy
Most Commonly Denied CAD Patients
In The USA

- As of 2013 only 5% of all primary isolated CABG cases in the STS Database had BITA; EACTS approx 10%.
- Japan, Korea and isolated sites elsewhere (much) higher
Why Should OPCAB Be Better?

- CABG/CPB entails extracorporeal circulation, aortic cannulation and clamping, global myocardial ischemia, hypothermia, hemodilution etc.
- OPCAB avoids these deleterious effects of CPB by mechanically stabilizing each coronary artery target individually, while the rest of the heart beats and supports normal physiologic circulation.
- *If* a complete revascularization with precise anastomoses can be accomplished without CPB, then the patient will benefit.
SMART Trial: Early Results

Off-pump coronary artery bypass grafting provides complete revascularization with reduced myocardial injury, transfusion requirements, and length of stay: A prospective randomized comparison of two hundred unselected patients undergoing off-pump versus conventional coronary artery bypass grafting

Objective: Retrospective comparisons of selected patients undergoing off-pump versus conventional on-pump coronary artery bypass grafting have yielded inconsistent results and raised concerns about completeness of revascularization in off-pump coronary artery bypass grafting.

Methods: Two hundred unselected patients referred for elective primary coronary artery bypass grafting were randomly assigned to undergo off-pump coronary artery bypass grafting with an Octopus tissue stabilizer (Medtronic, Inc, Minneapolis, Minnesota) or conventional coronary artery bypass grafting with cardiopulmonary bypass by a single surgeon. Revascularization intact determined before random assignment was compared with the revascularization performed. All management protocols were pre-defined, rigid, evidence-driven protocols. Patients and nonoperative care providers were blinded to surgical group.

Results: Baseline characteristics were similar. The number of grafts perfused per patient (mean ± SD 3.39 ± 1.04 for off-pump coronary artery bypass grafting, 3.40 ± 1.08 for conventional coronary artery bypass grafting) and the index of completeness of revascularization (number of grafts performed/number of grafts intended, 1.00 ± 0.38 for off-pump coronary artery bypass grafting, 1.01 ± 0.09 for conventional coronary artery bypass grafting) were similar. Likewise, the index of completeness of revascularization was similar between groups for the lateral wall. Combined hospital and 30-day mortalities and stroke rates were similar. Postoperative myocardial enzyme enzyme measures were significantly lower after off-pump coronary artery bypass grafting, suggesting less myocardial injury. Altered postoperative thromboplastin ratio, fibrogen, international normalized ratio, and platelet levels all showed significantly less coagulopathy after off-pump coronary bypass.

Presented at AATS 2002
Published in JTCVS 2003
Similar completeness of revascularization in unselected patients
Significant in-hospital benefits of OPCAB:
  - Lower enzyme release
  - Less transfusion
  - More rapid extubation
  - Shorter length of stay

From the Division of Cardiothoracic Surgery, Cardiology, and Cardiac Rehabilitation, Emory University School of Medicine, and the Emory Heart and Vascular Center for Outcome Research, Atlanta, Ga.

Supported by grants from Medtronic, Inc, Minneapolis, Minn, and The Cardiac Research Trust (Carr Center Foundation, Atlanta, Ga), and the Southern Society for Thoracic Surgery, New York, NY.

© 2003 by The American Association for Thoracic Surgery

The Journal of Thoracic and Cardiovascular Surgery • Volume 126, Number 4 • 2003
SMART Trial
Index of Completeness of Revascularization: (COR)

- Number of grafts performed per patient:
  \( 3.39 \pm 1.04 \) OPCAB vs \( 3.40 \pm 1.08 \) CABG/CPB

- Index of completeness of revascularization:
  \( 1.00 \pm 0.18 \) OPCAB vs \( 1.01 \pm 0.09 \) CABG/CPB

- ICOR also similar for lateral wall:
  \( 0.97 \pm 0.23 \) OPCAB vs \( 0.98 \pm 0.10 \) CABG/CPB

- Percent arterial grafts:
  41.3\% OPCAB vs 40.8\% CABG/CPB
  (All comparisons, \( p=NS \))
Coagulopathy and Transfusion

- CPB was an independent predictor of transfusion by multivariate analysis:

  Odds Ratio 2.42  p=0.0073
SMART Trial: Length of Stay

- Postoperative LOS was shorter in OPCAB:

  \[5.1 \pm 6.5 \text{ days OPCAB vs } 6.1 \pm 8.2 \text{ days CABG/CPB}\]

  \[p=0.005 \text{ Wilcoxon}\]
CPK-MB and Troponin I Release

CPK-MB

Troponin I

Hours After Operation

NG/ML

CPB

OPCAB

* p<0.001

Wilcoxon

NS

Mount Sinai Heart
SMART Trial: Midterm Results

Off-Pump vs Conventional Coronary Artery Bypass Grafting: Early and 1-Year Graft Patency, Cost, and Quality-of-Life Outcomes A Randomized Trial

John D. Parkash, MD, MSc
Willis H. Williams, MD
Elizabeth M. Maloney, ScD
Phillip E. Huber, MD
Peter C. Black, MD
Peggy C. Duker, MD
James H. Staples, MD
Katherine E. Glass, MD
J. Jeffrey Marshall, MD
Mark E. Leimbach, MD
Susan A. McCall, RN
Rebecca J. Petersen, RN
Deanne E. Bailey, RN, PA-C
William S. Weinstein, MD
Robert A. Guyton, MD

Context Previous trials of off-pump coronary artery bypass (OPCAB) have enrolled selected patients and have not rigorously evaluated long-term graft patency. A preliminary report showed OPCAB achieved improved endothelial outcomes, similar completeness of revascularization, and shorter lengths of stay compared with conventional coronary artery bypass grafting (CABG).

Objective To assess graft patency, clinical and quality-of-life outcomes, and cost among patients enrolled in the hospital and at 1 year follow-up.

Design, Setting, and Patients Randomized controlled trial of patients selected for coronary anatomy, ventricular function, or comorbidities between March 15, 2000, and August 20, 2001, at a US academic center. A total of 200 patients were enrolled: 3 patients were withdrawn after randomization for mitral valve repair or replacement. Follow-up was complete for 197 patients at 30 days, 185 at 1 year.

Interventions One surgical session consisting of selective OPCAB or CABG with cardiopulmonary bypass. The surgeon had extensive experience performing off-pump surgery; patients were subsequently managed by blinded protocols.

Main Outcome Measures Coronary angiography documented graft patency prior to hospital discharge and at 1 year; health-related quality of life, and cost of the index and subsequent hospitalizations.

Results Graft patency was similar for OPCAB and conventional CABG with cardiopulmonary bypass at 30 days (absolute difference, 1.3%; 95% confidence interval [CI], −0.60% to 3.21%; P = .19) and at 1 year (absolute difference, 2.2%; 95% CI, −6.1% to 1.7%; P = .27). Rates of death, stroke, myocardial infarction, angina, and reintervention were similar at 30 days and 1 year. There were no significant differences in health-related quality of life. Mean total hospitalization cost per patient at hospital discharge was $2272 (95% CI, $755–$3723) less for OPCAB (P = .002) and $1955 (95% CI, −$5765 to $4222) less at 1 year (P = .08).

Conclusions In this randomized single-surgeon trial among unscreened patients with angiographic follow-up, OPCAB achieved similar graft patency in the hospital and at 1 year. Cardiac outcomes and health-related quality of life at 30 days and 1 year were similar and patients incurred a lower cost. OPCAB may provide complete revascularization that is durable and cost-effective.

Author Affiliations: Divisions of Cardiothoracic Surgery, Emory University, Atlanta, and Georgia Regents University, Augusta, Georgia (Dr Parkash, Williams, and Guyton and Ms McCall, Petersen, and Bailey); Cardiology (Dr Huber), Emory University, Atlanta, and Atlanta Medical Center, Atlanta, Georgia (Dr Glass); Anesthesiology (Dr Duker, Staples, and Glass); Emory University, Atlanta, and American Heart Association, Atlanta, Georgia (Dr Glass); and Emory University, Atlanta, and Emory University Hospital Midtown, Atlanta, Georgia (Dr Glass). Funding/Support: Dr Parkash is a consultant for Model Health Solutions, Inc. Dr Williams is a consultant for Somewhat Healthier, Inc. Corresponding Author: John D. Parkash, MD, MSc, Cardiothoracic Surgery, Emory University Hospital Midtown, 505 5th St NW, Atlanta, GA 30318 (john.parkash@emory.edu).

Complete follow-up:
- 100% at 30 days
- 94% at 1 year

Rates of death, stroke, MI, angina, reintervention similar at 30 days and 1 yr.

Graft patency similar in-hospital and at 1 year

QOL indices not significantly different (P<0.01) between groups

Cost: $2272 less for OPCAB in-hospital (P=0.002) and $1955 less at 1 year (P=0.08).
Acute Graft Patency by Fitzgibbon Score
184 of 197 Patients (93.4%)
622 Grafts

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
<th>A + B</th>
<th>O</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td>OPCAB</td>
<td>96.8</td>
<td>2.2</td>
<td>99.0</td>
<td>1.0</td>
<td>315</td>
</tr>
<tr>
<td>CPB</td>
<td>95.4</td>
<td>2.0</td>
<td>97.4</td>
<td>2.6</td>
<td>307</td>
</tr>
</tbody>
</table>
1 Year Graft Patency by Fitzgibbon Score
153 of 189 Patients (81.4%)
511 Grafts

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
<th>A + B</th>
<th>O</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td>OPCAB</td>
<td>90.0</td>
<td>3.6</td>
<td>93.6</td>
<td>6.4</td>
<td>251</td>
</tr>
<tr>
<td>CPB</td>
<td>94.3</td>
<td>1.5</td>
<td>95.8</td>
<td>4.2</td>
<td>261</td>
</tr>
</tbody>
</table>
Survival by Surgery Type

Survival Distribution Function

$p=0.71$

$p=0.06$

$p=0.02$

$p=0.09$

$p=0.33$

Years

STRATA: TYPE=CABG on CPB, TYPE=OPCAB
Coronary Re-intervention at 8 Years FU

- 1/43 (2.3%) OPCAB pts had PCI
- 1/44 (2.3%) CPB pts had PCI

p = 1.0

- No patient in either group has had redo CABG
Off-Pump Techniques Benefit Men and Women and Narrow the Disparity in Mortality After Coronary Bypass Grafting

John D. Puskas, MD, Fred H. Edwards, MD, Paul A. Pappas, MS, Sean O’Brien, PhD, Eric D. Peterson, MD, MPH, Patrick Kilgo, MS, and T. Bruce Ferguson, Jr, MD

Emory University, Atlanta, Georgia; University of Florida, Jacksonville, Florida; Duke Clinical Research Institute, Duke University School of Medicine, Durham, and Eastern Carolina University, Greenville, North Carolina

Background. Women have historically had greater morbidity and mortality than men after conventional coronary artery bypass grafting (CABG) on cardiopulmonary bypass (ONCAB). It is controversial whether off-pump CABG (OPCAB) alters this gender-based disparity.

Methods. The Society of Thoracic Surgeons National Cardiac Database was reviewed for risk factors and clinical outcomes of 42,477 consecutive, nonemergency, isolated, primary ONCAB or OPCAB cases performed at 63 North American centers that performed more than 100 OPCAB cases between January 1, 2004, and December 31, 2005. Odds ratios for adverse events, adjusted for 32 clinical and demographic covariates, were compared by multiple logistic regression models between women and men who had OPCAB versus ONCAB. All analyses were by intention-to-treat; 355 (2.2%) patients converted from OPCAB to ONCAB intraoperatively were included in the OPCAB group.

Results. Women (n = 11,785) and those treated with OPCAB (n = 16,245) were older and had more comorbidities than men (n = 30,662) and those treated with conventional ONCAB (n = 26,202). Overall, adjusted odds ratios for death and most major complications in both men and women were significantly lower with OPCAB than with ONCAB. Among ONCAB cases only, women had a significantly greater adjusted risk of death, prolonged ventilation, and long length of stay than men. In contrast, among OPCAB cases, women had lower risk of reexploration than men and similar risks for death, myocardial infarction, and prolonged ventilation and hospital stay.

Conclusions. OPCAB is associated with lower adjusted risk of death and major adverse events than ONCAB. OPCAB benefits both men and women and reduces the gender disparity in clinical outcomes after CABG.

Study Cohort (Intent-to-Treat)

- 42,477 consecutive patients:
  
  16,245 OPCAB vs 26,232 CPB

- 63 North American centers, including 8 with cardiothoracic residency programs

- Of the 16,245 OPCAB cases, 355 (2.2%) were converted during surgery from an initial OPCAB approach to ONCAB and were analyzed within the OPCAB group.
Risk-Adjusted Odds Comparisons
OPCAB vs ONCAB:

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Adjusted OR</th>
<th>(95% CI)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Death</td>
<td>0.83</td>
<td>(0.69, 0.98)</td>
<td>0.03</td>
</tr>
<tr>
<td>Stroke</td>
<td>0.65</td>
<td>(0.52, 0.80)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>MI</td>
<td>0.67</td>
<td>(0.54, 0.84)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>MACE</td>
<td>0.71</td>
<td>(0.63, 0.81)</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>
## Risk-Adjusted Odds Comparisons

**OPCAB vs ONCAB: Other Outcomes**

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Adjusted OR</th>
<th>(95% CI)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Renal Failure</td>
<td>0.74</td>
<td>(0.64, 0.86)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Dialysis</td>
<td>0.63</td>
<td>(0.50, 0.80)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Sternal Infection</td>
<td>0.67</td>
<td>(0.46, 0.98)</td>
<td>0.04</td>
</tr>
<tr>
<td>Reoperation</td>
<td>0.86</td>
<td>(0.78, 0.95)</td>
<td>0.004</td>
</tr>
<tr>
<td>AF</td>
<td>0.88</td>
<td>(0.83, 0.94)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Prolonged Vent*</td>
<td>0.75</td>
<td>(0.69, 0.82)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>LOS &gt; 14 days</td>
<td>0.70</td>
<td>(0.63, 0.78)</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>
Off-Pump Coronary Artery Bypass Disproportionately Benefits Patients With Higher Society of Thoracic Surgeons Predicted Risk Of Mortality


Emory University
Atlanta, USA

Society of Thoracic Surgeons
January 27, 2009
San Francisco
Results

- There were 14766 consecutive patients; 7083 OPCAB (48.0%) and 7683 CPB (52.0%).

- There was no difference in operative mortality between OPCAB and CPB for patients in the lower two risk quartiles.

- In the higher risk quartiles there was a mortality benefit for OPCAB (odds ratio 0.62 and 0.45 for OPCAB in the third and fourth risk quartiles).
Off-Pump Coronary Artery Bypass
Disproportionately Benefits Higher Risk Patients
After Adjustment for Patient Factors, Center Volume and Surgeon Identity

John D Puskas MD*,  Sean S. O’Brien PhD**
and Xia He MS**

*Division of Cardiothoracic Surgery, Emory University
and
**Duke Clinical Research Institute, Duke University

American Association for Thoracic Surgery
Annual Meeting 2012
San Francisco
Methods

- The STS National Cardiac Database queried for all isolated, primary CABG cases between 1/1/2005 and 12/31/2010

- Of these 876,081 cases (“All Sites”), 210,469 were at participant sites that performed >300 OPCAB and >300 CPB cases during the 6-year study period (“High Volume Sites”).

- Operative mortality, stroke, ARF, M+M, and PLOS >=14d were analyzed with conditional logistic models, stratified by participant and by surgeon and adjusted for all 30 variables that comprise the STS PROM score.
Results

- OPCAB was associated with significant reduction in risk of death, stroke, ARF, M+M and PLOS>14d, compared to CABG/CPB after adjustment for 30 patient risk factors in the overall sample.

- This held true within high volume centers alone, and was somewhat more pronounced after adjustment for surgeon effect.
Mortality or Major Morbidity For All Patients: OPCAB vs CPB at Varying Levels of PROM
OPCAB in High-Risk Patients
Lemma et al, JTCVS 2012;143:625-31

• Multicenter, prospective, randomized trial of 411 patients referred for isolated CABG at 8 European centers
• 1:1 “experience-based” randomization—each surgeon had chosen OPCAB or ECC as their “prevalent” strategy and performed at least 50-100 CABG cases annually
• Euroscore ≥ 6
• Excluded: shock, IABP, concomitant procedures, porcelain aorta
OPCAB in High-Risk Patients

Lemma et al, JTCVS 2012;143:625-31

- Primary endpoint: death, MI, stroke or TIA, RF, ARDS, reop for bleeding
- OPCAB (5.8%) vs ECC (13.3%) (OR 2.5; 95% CI 1.23-5.10; p=0.01)

<table>
<thead>
<tr>
<th>TABLE 3. Primary end point</th>
</tr>
</thead>
<tbody>
<tr>
<td>End point</td>
</tr>
<tr>
<td>Composite</td>
</tr>
<tr>
<td>Operative mortality</td>
</tr>
<tr>
<td>Myocardial infarction</td>
</tr>
<tr>
<td>Stroke</td>
</tr>
<tr>
<td>Renal failure</td>
</tr>
<tr>
<td>Reoperation for bleeding</td>
</tr>
<tr>
<td>ARDS</td>
</tr>
</tbody>
</table>
Off-Pump and On-Pump Coronary Revascularization in Patients With Low Ejection Fraction: A Report From The Society of Thoracic Surgeons National Database

W. Brent Keeling, MD, Matthew L. Williams, MD, Mark S. Slaughter, MD, Yue Zhao, PhD, and John D. Puskas, MD

Division of Cardiothoracic Surgery, Emory University, Atlanta, Georgia; Division of Cardiothoracic Surgery, University of Louisville, Louisville, Kentucky; and Duke Clinical Research Institute, Durham, North Carolina

Background. The purpose of this study was to evaluate outcomes of patients with low ejection fraction who underwent surgical coronary revascularization with or without cardiopulmonary bypass (CPB).

Methods. The Society of Thoracic Surgeons National Database was queried from January 1, 2008, to June 30, 2011 for patients with an ejection fraction of less than 0.30 who underwent primary, nonemergent coronary artery bypass (CAB) grafting. The entire cohort of 25,667 patients was divided into those who underwent revascularization with (ONCAB, n = 20,509) and without (OPCAB, n = 5,158) CPB. OPCAB patients who were converted to CPB intraoperatively were counted as intended OPCAB and were included in the OPCAB group. Propensity scores were estimated using 32 covariates, and multivariate logistic regression was used to compare risk-adjusted outcomes between groups.

Results. Patients undergoing planned OPCAB were older, more frequently female, and had a lower body mass index than those who underwent ONCAB. The OPCAB cohort also had higher rates of prior stroke, peripheral vascular disease, and chronic lung disease. The predicted mortality risk was 2.3% for the OPCAB cohort vs 2.1% for the ONCAB group (p < 0.0001). Of the 5,158 patients who underwent OPCAB, unplanned conversion to CPB occurred in 270 (5.2%). OPCAB was associated with significantly lower adjusted risk of death (odds ratio [OR], 0.82), stroke (OR, 0.67), major adverse cardiac events (OR, 0.75), and prolonged intubation (OR, 0.78). Postoperative transfusion rates were significantly lower in the OPCAB group (44.8% vs 51.6%, p < 0.001). There were no adverse outcomes that occurred more commonly in OPCAB patients. The advantage associated with OPCAB was found in the entire Society of Thoracic Surgeons National Database and among high-volume and low-volume OPCAB centers.

Conclusions. In The Society of Thoracic Surgeons National Database, OPCAB is associated with significantly reduced adjusted risk of early morbidity and mortality for patients having coronary bypass grafting with an ejection fraction of less than 0.30.

© 2013 by The Society of Thoracic Surgeons
Methods

• STS National Database review from 1/1/2008 to 12/31/2011 of all elective or urgent primary CABG cases with echo-documented EF≤30%.
• Excluded: emergent/salvage, STEMI patients
• 25,667 patients for intention-to-treat analysis
• Volume and non-volume dependent analysis – threshold 50 case/center for each technique for 3 years preceding study period (122 total centers)
• Propensity matching using 32 covariates
## Propensity-Matched Results

<table>
<thead>
<tr>
<th>Outcome</th>
<th>OR</th>
<th>95% CI</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>In-hospital Mortality</td>
<td>0.8178</td>
<td>0.6714-0.9961</td>
<td>0.0456</td>
</tr>
<tr>
<td>Stroke &gt;72 hr</td>
<td>0.6710</td>
<td>0.5049-0.8916</td>
<td>0.0059</td>
</tr>
<tr>
<td>Perioperative MI</td>
<td>0.6550</td>
<td>0.4004-1.0716</td>
<td>0.0920</td>
</tr>
<tr>
<td>MACE (In-hospital mortality, MI, Stroke&gt;72 hr)</td>
<td>0.7481</td>
<td>0.6360-0.8798</td>
<td>0.0005</td>
</tr>
<tr>
<td>Mediastinitis</td>
<td>1.0364</td>
<td>0.6633-1.6193</td>
<td>0.8753</td>
</tr>
<tr>
<td>Septicemia</td>
<td>0.8770</td>
<td>0.6542-1.1757</td>
<td>0.3802</td>
</tr>
<tr>
<td>Renal failure</td>
<td>0.9670</td>
<td>0.8358-1.1188</td>
<td>0.6522</td>
</tr>
<tr>
<td>Dialysis</td>
<td>0.9445</td>
<td>0.7481-1.1925</td>
<td>0.6313</td>
</tr>
<tr>
<td>Prolonged Ventilation</td>
<td>0.7775</td>
<td>0.7122-0.8488</td>
<td>&lt;.0001</td>
</tr>
</tbody>
</table>
395 consecutive clampless OPCAB (310 PAS-Port; 85 all-arterial without proximals)

Propensity Score matching on 15 preop risk variables to compare outcomes among 394 pairs of clampless OPCAB vs cCABG:

- In-hospital death (OR 0.25; 95% CI 0.05-1.18; p=0.08)
- Stroke (OR 0.36; 95% CI 0.13-0.99; p=0.048)
- Death or Stroke (OR 0.27; 95% CI 0.11-0.67; p=0.005)

- 2 years F/U:  
  - Death (OR 0.39; 95% CI 0.19-0.80; p=0.01),  
  - Death or Stroke (OR 0.58; 95% CI 0.34-1.00; p=0.05)
- MACCE (OR 0.62; 95% CI 0.37-1.02; p=0.06)
- Repeat revasc (OR 0.74; 95% CI 0.40-1.38; p=0.35)
Aortic No-Touch Technique Makes the Difference in OPCAB
Emmert et al JTCVS 2011; 142:1499-506.

- Two OPCAB groups: PC n=567 vs HS n=1365
- Propensity-adjusted regression, HS vs PC:
  - Stroke (0.7% vs 2.3%; OR 0.39; CI 95% 0.16-0.90; p=0.04)
  - MACCE (6.7% vs 10.8%; OR 0.55; CI 95% 0.38-0.79; p=0.001)
- Stroke rate similar between cCABG and PC OPCAB
Clampless All-Arterial
OPCAB x 5

Mount Sinai Hospital, May 2014
Clampless Total Arterial OPCABG X 5: BIMA + BRA
History

- 48 M
- HTN, Hyperlipidemia
- Angina on exertion for last 2-3 months
- Myocardial perfusion scan showed extensive reversible ischemia in multiple territories
- s/p PCI in 2/2011, 2 Cx stents
Coronary Angiogram

- 80% mid & distal LAD
- 80% D2
- 80% mid Cx
- 90% OM2
- 100% RCA
- LVEF- 60%
Clampless Total Arterial OPCABG X 5: BIMA + BRA

- LIMA & Radial 1, side-side
- Radial 1-end-side-D2
- Radial 1-end-side-OM 2
- Radial 2 –LPL-clampless prox. on Aorta
- RIMA- end-end-piece of Radial 1 – end-side-RCA
Hybrid coronary revascularization (defined as the planned combination of LIMA-to-LAD artery grafting and PCI of ≥1 non-LAD coronary arteries) may be reasonable as an alternative to multivessel PCI or CABG in an attempt to improve the overall risk-benefit ratio of the procedures.
HCR: Combining Positive Features From Both CABG And PCI

- FREEDOM FROM PROCEDURAL RISK AND INVASION
- DURABILITY (Freedom from re-intervention) AND SURVIVAL

PCI: Less Invasion

HYBRID

CABG: Higher Durability
Case #1

- 80 yo previously active male presented with NSTEMI
- History significant for DM and renal insufficiency
- Troponin peaked at 2.2
- Taken to cardiac catheterization lab
Cath-LCA injection
Cath-RCA injection
Robotic LIMA Harvest
Incisions
Postoperative course

- Unremarkable postoperative course
- Discharged home on POD#3
- Return for PCI to RCA in 4 weeks
LIMA injection
PTCA RCA
Completion Angio
Case #2

- 57 yo male transferred from outside hospital with NSTEMI
- Multivessel CAD on cath including LM
- RCA normal
- No significant past medical history
- Strong family history for CAD
Angiogram-LCA
Angiogram-LCA
Plan

- Robotic assisted LIMA-LAD
- Subsequent PCI of LM into circumflex on POD #1
LIMA injection postop
PTCA of LM into LCx with DES
PTCA of LM into LCx with DES
Completion Angio
Postoperative Course

- Taken to cath lab on POD#1
- Uncomplicated procedure
- Discharged home POD#3
- Back to work 2 weeks
4 Weeks after Surgery
Improved CABG for Complex CAD

- CABG is associated with better outcomes than PCI for most patients with complex CAD, especially diabetics: SYNTAX and FREEDOM
- BITA grafting prolongs life
- Radial Arteries are (usually) better than veins
- OPCAB can be better than ONCAB, but requires special expertise
- Clampless OPCAB, by avoiding/minimizing manipulation of the ascending aorta, is associated with lower risk of stroke
- All-arterial, clampless OPCAB is state-of-the-art CABG
- Hybrid Coronary Revascularization may offer unique advantages to selected patient subsets