



On-Pump vs Off-Pump CABG*

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* Coronary Artery Bypass Grafting

Tribute to Michael De Bakey

Morris was removing some engine valves from a car on the lift when he spotted the famous heart surgeon Dr. Michael De Bakey, who was standing off to the side, waiting for the service manager. Morris, somewhat of a loud mouth, shouted across the garage, "Hey De Bakey...Is that you? Come over here a minute."

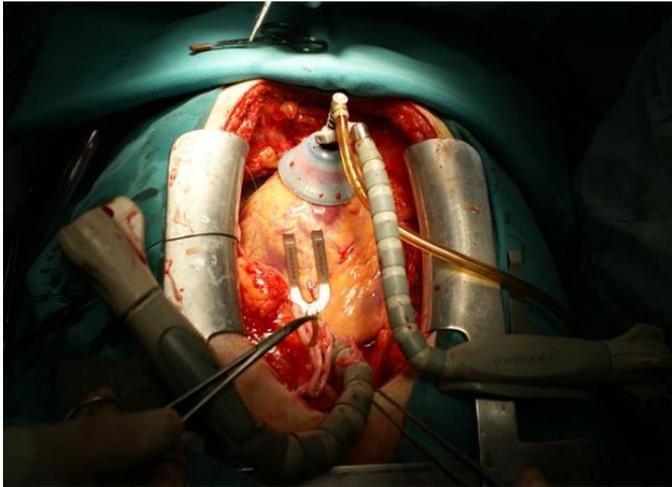
The famous surgeon, a bit surprised, walked over to where Morris was working on a car. Morris in a loud voice, all could hear, said argumentatively, "So Mr. fancy doctor, look at this work. I also take valves out, grind them, put in new parts, and when I finish this baby will purr like a kitten. So how come you get the big bucks, when you and me are doing basically the same work?"

De Bakey, very embarrassed, walked away and said softly, to Morris, "Try doing your work with the engine running."

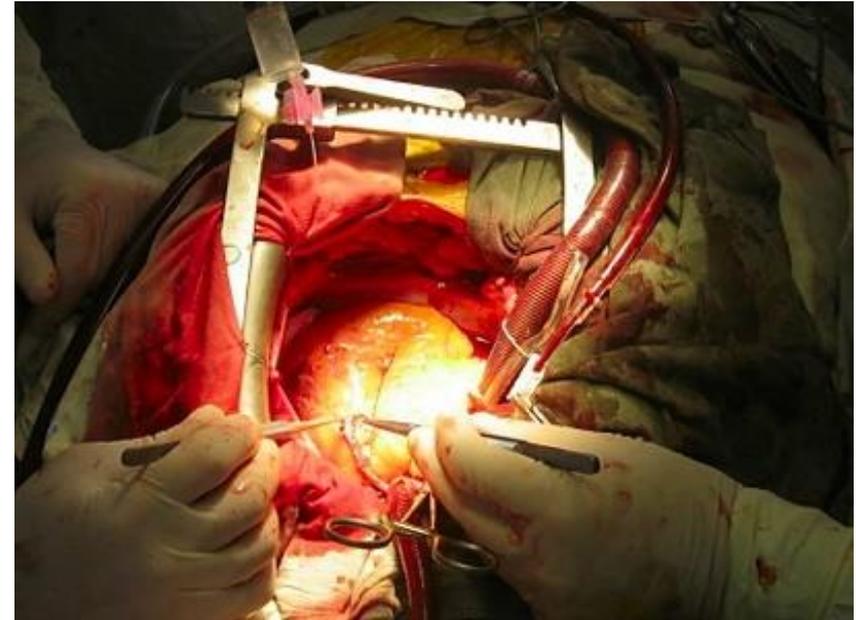


Off-pump CABG - On-pump CABG

- “**Off-pump CABG**” is **CABG** performed without the use of a heart-lung machine (cardiopulmonary bypass). This means the heart continues to provide blood to the rest of the body during the surgery.
- In **off-pump CABG**, the area around the blocked coronary artery is stabilized while the surgeon grafts the blood vessel on the “**beating**” heart.

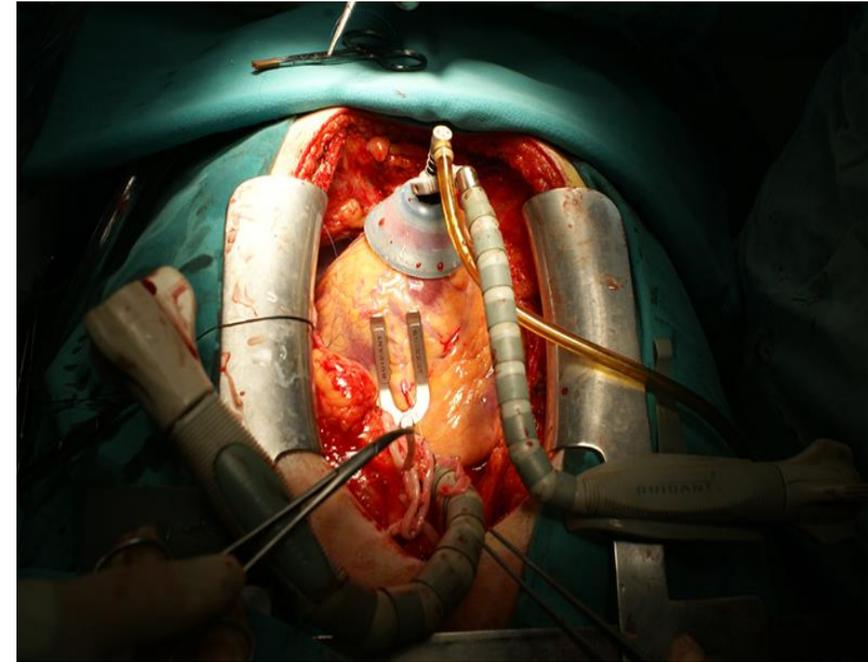


- In “**on-pump CABG**”, the heart is stopped with the body's blood supply being maintained by the cardio-pulmonary bypass (CPB) machine.



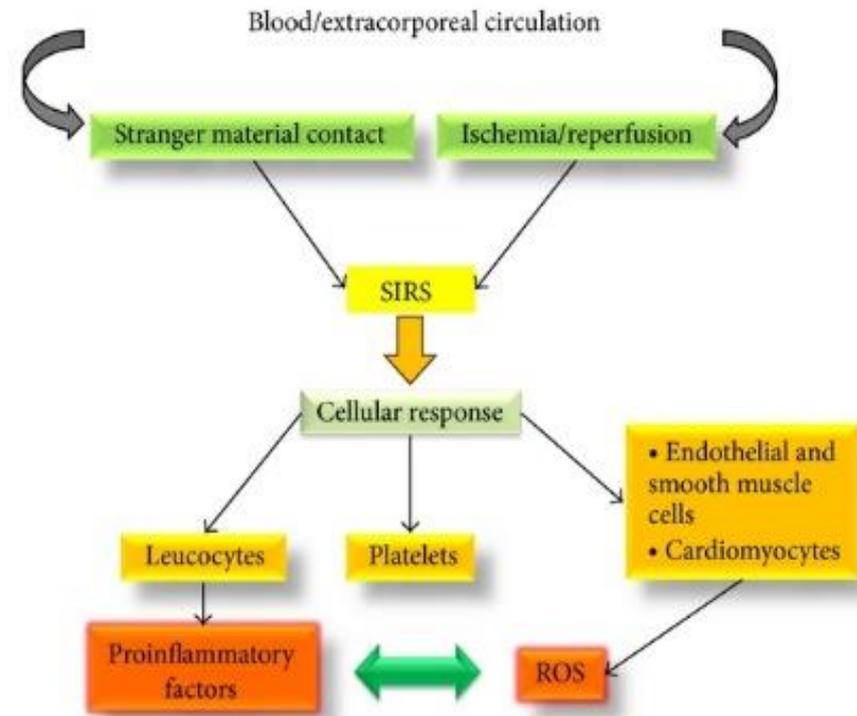
Off-pump CABG - On-pump CABG

- The initial CABGs in the 1960s were performed “off pump” because of the lack of cardiopulmonary bypass technology.
- The popularity of CABG without cardiopulmonary bypass (“off-pump”) peaked in 2002 (in some centers with 120-130 % of coronary bypass operations !!!).
- When it was popular in 2002, it constituted approximately 23% of CABG procedures and then declined to 17% by 2012 in the United States and Germany.
- With the subsequent development of safe and effective cardiopulmonary bypass, most CABGs are now performed “on pump”.
- Off-pump CABG is highly prevalent in Asia and South America mainly because of economic reasons.



Cardiopulmonary bypass – SIRS

- **Systemic inflammatory response syndrome (SIRS)**, is an inflammatory state affecting whole body. **Surgical trauma and stress, anesthesia and mechanical ventilation,** and subsequent intensive care unit stay may induce SIRS.
- **Cardiac surgery with cardiopulmonary bypass and aortic cross-clamping** may exponentially provoke systemic inflammatory response syndrome.



Hirai S. Systemic inflammatory response syndrome after cardiac surgery under cardiopulmonary bypass. *Ann Thorac Cardiovasc Surg.* 2003 Dec;9(6):365-70.

Off-pump CABG - On-pump CABG

- The ROOBY TRIAL- 2009 (Randomized On/Off Bypass Trial) (~ 1100 patients on each arm) showed that
 - at 1 year, those in the off pump group had worse outcomes as
 - poorer graft patency,
 - greater incidence of incomplete revascularization

Table 3. Graft Patency and FitzGibbon A Classification by Major Coronary Region, Target Artery, and/or Conduit

| | Off Pump, n/N (%) | On Pump, n/N (%) | P |
|---|-------------------|------------------|--------|
| Patency of all grafts to LAD territory | 831/935 (88.9) | 865/941 (91.9) | 0.03 |
| FitzGibbon A to LAD territory | 778/935 (83.2) | 840/941 (89.3) | <0.001 |
| Patency of all grafts to circumflex territory | 434/554 (78.3) | 523/616 (84.9) | 0.004 |
| FitzGibbon A to circumflex territory | 411/554 (74.2) | 498/616 (80.8) | 0.008 |
| Patency of all grafts to RCA territory | 385/509 (75.6) | 450/537 (83.8) | 0.001 |
| FitzGibbon A to RCA territory | 360/509 (70.7) | 429/537 (79.9) | <0.001 |

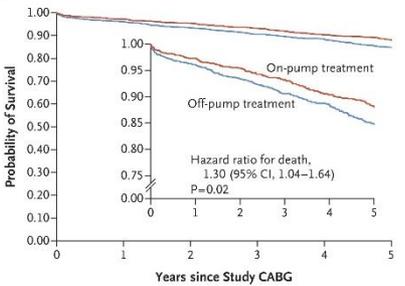
Table 4. Quality of Revascularization at Angiographic Follow-Up*

| | Off Pump, n/N (%) | On Pump, n/N (%) | Relative Risk† (95% CI) | P |
|--|-------------------|------------------|-------------------------|--------|
| Patient with all grafts patent | 435/685 (63.5) | 488/685 (71.2) | 0.89 (0.83–0.96) | 0.003 |
| LAD territory effectively revascularized‡ | 580/665 (87.2) | 623/672 (92.7) | 0.94 (0.91–0.98) | 0.001 |
| Circumflex territory effectively revascularized‡ | 355/525 (67.6) | 417/538 (77.5) | 0.87 (0.81–0.94) | <0.001 |
| RCA territory effectively revascularized‡ | 329/516 (63.8) | 390/522 (74.7) | 0.85 (0.79–0.93) | <0.001 |
| Patient effectively revascularized§ | 343/685 (50.1) | 438/685 (63.9) | 0.78 (0.71–0.86) | <0.001 |

On-Pump versus Off-Pump Coronary-Artery Bypass Surgery
A. Laurie Shroyer, Ph.D., Frederick L. Groves, M.D., Brack Hattler, M.D., Joseph F. Collins, Sc.D., Gerald D. McDonald, M.D., Elizabeth Kozora, Ph.D., John C. Lurie, M.D., Janet H. Baltz, R.N., and Dimitri Neovizky, M.D., Ph.D., for the Veterans Affairs Randomized On/Off Bypass (ROOBY) Study Group

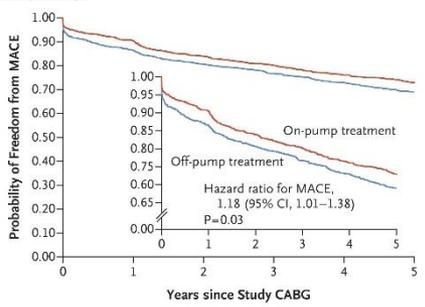
- at 5 year, those in the off pump group had worse outcomes as
 - higher mortality & MACE

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

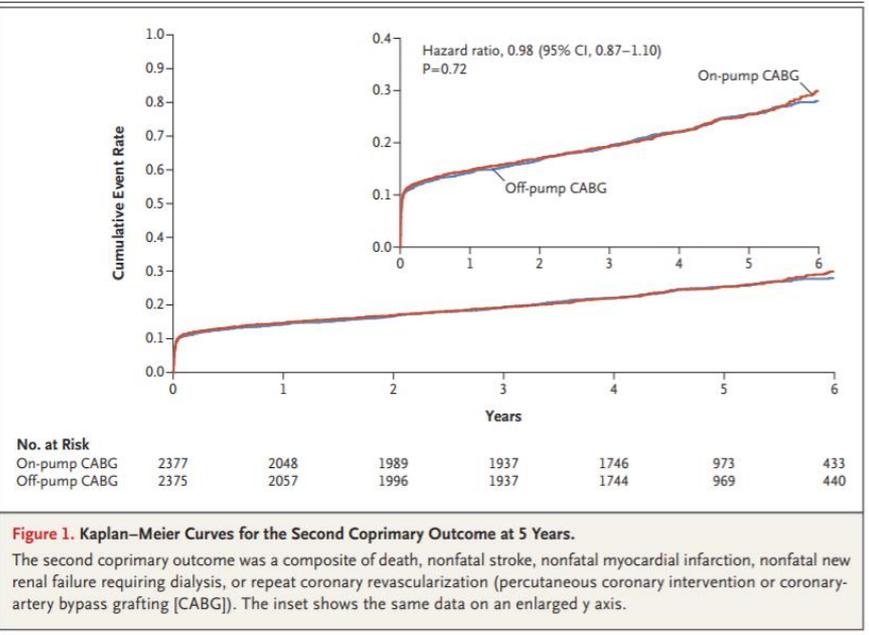


| No. at Risk | 0 | 1 | 2 | 3 | 4 | 5 |
|--------------------|------|-----|-----|-----|-----|-----|
| On-pump treatment | 1099 | 994 | 923 | 881 | 836 | 801 |
| Off-pump treatment | 1104 | 955 | 890 | 847 | 805 | 762 |

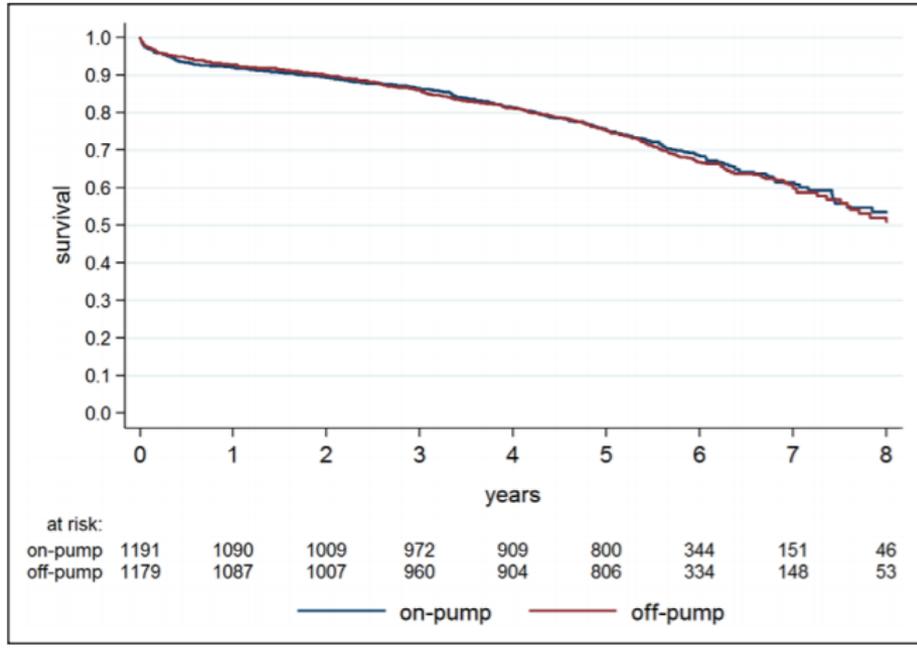
Five-Year Outcomes after On-Pump and Off-Pump Coronary-Artery Bypass
A. Laurie Shroyer, Ph.D., Brack Hattler, M.D., Todd H. Wagner, Ph.D., Joseph F. Collins, Sc.D., Janet H. Baltz, R.N., Jacquelyn A. Quinn, M.D., G. Hossein Almassi, M.D., Elizabeth Kozora, Ph.D., Faisal Bakaeen, M.D., Joseph C. Cleveland, Jr., M.D., Muath Bishawi, M.D., and Frederick L. Grover, M.D., for the Veterans Affairs ROOBY-FS Group*

Off-pump CABG - On-pump CABG

- However,
 - CORONARY STUDY (CABG Off or On Pump Revascularization Study - involving 4752 patients) and
 - GOPCABE TRIAL (German Off-Pump Coronary Artery Bypass Grafting in Elderly Patients- involving 2539 patients) showed that there is no difference in outcomes at 1 and 5 years, between off and on-pump groups.



Five-Year Outcomes after Off-Pump or On-Pump Coronary-Artery Bypass Grafting. N Engl J Med 2016;375:2359-68

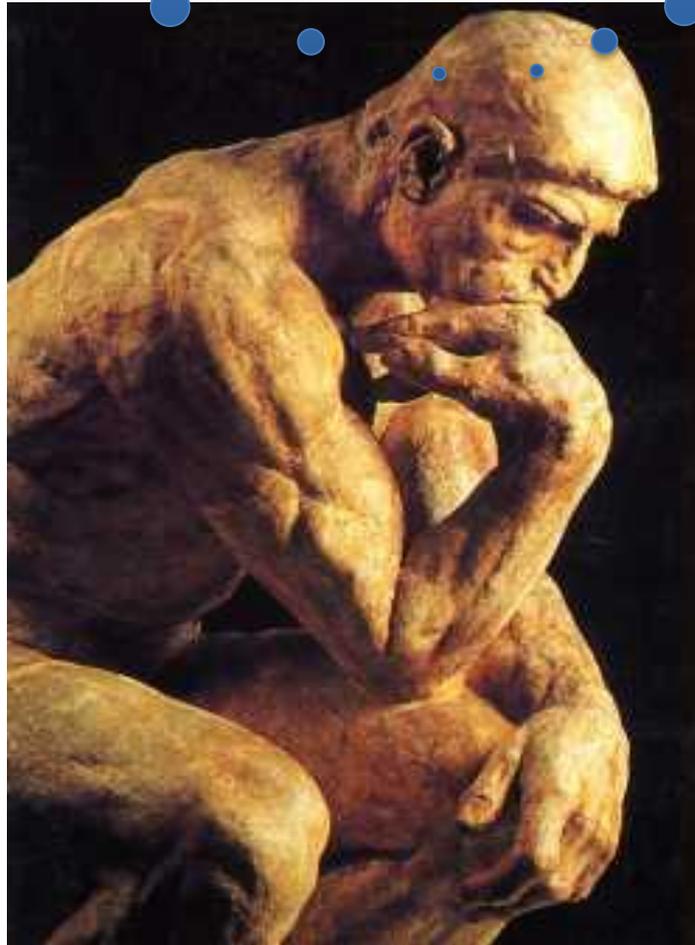


Five-Year Outcome After Off-Pump or On-Pump Coronary Artery Bypass Grafting in Elderly Patients. Circulation. 2019;139:1865-1871.

Off-pump CABG - On-pump CABG

On-pump CABG...

or Off-Pump CABG?



Fundamentals in Cardiac Surgery:

Course Directors

S Livesey, London

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European Association For Cardio-Thoracic Surgery

On-pump or Off-pump CABG

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Raising Standards through Education and Training

Off-pump CABG - On-pump CABG

on-pump off-pump

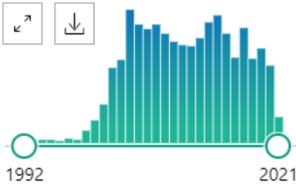
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RESULTS BY YEAR



TEXT AVAILABILITY

- Abstract
- Free full text
- Full text

ARTICLE ATTRIBUTE

- Associated data

ARTICLE TYPE

On-pump versus off-pump coronary-artery bypass surgery.
1 Shroyer AL, Grover FL, Hattler B, Collins JF, McDonald GO, Kozora E, Lucke JC, Baltz JH, Novitzky D; Veterans Affairs Randomized On/Off Bypass (ROOBY) Study Group. N Engl J Med. 2009 Nov 5;361(19):1827-37. doi: 10.1056/NEJMoa0902905.
Share PMID: 19890125 **Free article.** Clinical Trial.
The rate of the 1-year composite outcome was higher for off-pump than for on-pump CABG (9.9% vs. 7.4%, P=0.04). The proportion of patients with fewer grafts completed than originally planned was higher with off-pump CABG than with on-pump CABG (17.8% v ...

Off-Pump Versus On-Pump Bypass Surgery for Left Main Coronary Artery Disease.
2 Benedetto U, Puskas J, Kappetein AP, Brown WM 3rd, Horkay F, Boonstra PW, Bogáts G, Noiseux N, Dressler O, Angelini GD, Stone GW, Serruys PW, Sabik JF, Taggart DP. J Am Coll Cardiol. 2019 Aug 13;74(6):729-740. doi: 10.1016/j.jacc.2019.05.063.
Share PMID: 31395122 **Free article.** Clinical Trial.
CABG was performed with or without cardiopulmonary bypass (on-pump vs. off-pump surgery) according to the discretion of the operator. The 3-year outcomes in the off-pump and on-pump groups were compared using inverse probability of treatment weighting ...



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doi:10.1093/ejcts/ezu366 Advance Access publication 29 August 2014



2014 ESC/EACTS Guidelines on myocardial revascularization

The Task Force on Myocardial Revascularization of the European Society of Cardiology (ESC) and the European Association for Cardio-Thoracic Surgery (EACTS)

Developed with the special contribution of the European Association of Percutaneous Cardiovascular Interventions (EAPCI)

ESC/EACTS
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Authors/Task Force members, Philippe Kolh* (EACTS Chairperson) (Belgium), Stephan Windecker* (ESC Chairperson) (Switzerland), Fernando Alfonso (Spain), Jean-Philippe Collet (France), Jochen Cremer (Germany), Volkmar Falk (Switzerland), Gerasimos Filippatos (Greece), Christian Hamm (Germany), Stuart J. Head (Netherlands), Peter Jüni (Switzerland), A. Pieter Kappetein (Netherlands), Adnan Kastrati (Germany), Juhani Knuuti (Finland), Ulf Landmesser (Switzerland), Günther Laufer (Austria), Franz-Josef Neumann (Germany), Dimitrios J. Richter (Greece), Patrick Schauerte (Germany), Miguel Sousa Uva (Portugal), Giulio G. Stefanini (Switzerland), David Paul Taggart (UK), Lucia Torracca (Italy), Marco Valgimigli (Italy), William Wijns (Belgium) and Adam Witkowski (Poland)

Off-pump CABG - On-pump CABG

16.3 Surgical procedures

16.3.6 On-pump and off-pump procedures

- There is some evidence that suggests that the **off-pump approach may reduce the risk of perioperative acute renal failure and/or progression to end-stage renal disease in these patients.**

13. 1 Associated carotid artery disease

13.1.2 Preventive measures to reduce the risk of stroke after coronary artery bypass grafting

- There is conflicting evidence regarding the influence of off-pump CABG on the incidence of stroke. A recent randomized trial showed no difference in the incidence of stroke between off-pump CABG and on-pump CABG at 30 days. However, studies employing **a 'minimal touch' technique for the aorta reported a lower risk of stroke and MACCE with off-pump CABG.**

Specific recommendations for patients with moderate or severe CKD

| Recommendations | Class ^a | Level ^b | Ref ^c |
|---|--------------------|--------------------|------------------|
| CABG should be considered over PCI in patients with multivessel CAD and symptoms/ ischaemia whose surgical risk profile is acceptable and life expectancy is beyond 1 year. | IIa | B | 25,382,390–392 |
| PCI should be considered over CABG in patients with multivessel CAD and symptoms/ischaemia whose surgical risk profile is high or life expectancy is less than 1 year. | IIa | B | 390,391 |
| It should be considered to delay CABG after coronary angiography until the effect of contrast media on renal function has subsided. | IIa | B | 393–395 |
| Off-pump CABG may be considered rather than on-pump CABG. | IIb | B | 396 |
| New-generation DES are recommended over BMS. | I | B | 375,376 |

16.3 Surgical procedures

16.3.6 On-pump and off-pump procedures.

- Despite improved techniques and experience, part of the morbidity related to CABG is caused by the extracorporeal circulation (cardiopulmonary bypass) and access for cardiopulmonary bypass, **prompting the off-pump approach**. Two recent large, international, randomized trials have shown **no difference in 30-day or 1-year clinical outcomes** between on- and off-pump surgery, **when performed by experienced surgeons**.
- There is also enough evidence to conclude that, **for most patients and surgeons, on-pump CABG provides the best—or equal—short and long-term outcomes**. **For some surgeons, off-pump CABG is associated with inferior early and late graft patency rates and possibly compromised long-term survival; however, complete off-pump procedures in the hands of highly trained teams appear to be associated with a reduced risk of early morbidity, such as stroke, wound and respiratory infections, as well as fewer transfusions and shorter hospital stay.**

Off-pump CABG - On-pump CABG

Procedural aspects of CABG

| Recommendations | Class ^a | Level ^b | Ref. ^c |
|---|--------------------|--------------------|--------------------------|
| It is recommended to perform procedures in a hospital structure and by a team specialized in cardiac surgery, using written protocols. | I | B | 635,636 |
| Endoscopic vein harvesting should be considered to reduce the incidence of leg wound complications. | IIa | A | 577,578,580–582, 637,638 |
| Routine skeletonized IMA dissection should be considered. | IIa | B | 586–589 |
| Skeletonized IMA dissection is recommended in patients with diabetes or when bilateral IMAs are harvested. | I | B | 586–589 |
| Complete myocardial revascularization is recommended. | I | B | 594,598,600 |
| Arterial grafting with IMA to the LAD system is recommended. | I | B | 602,603,639 |
| Bilateral IMA grafting should be considered in patients <70 years of age. | IIa | B | 165,606–610,640, 641 |
| Use of the radial artery is recommended only for target vessels with high-degree stenosis. | I | B | 618,642 |
| Total arterial revascularization is recommended in patients with poor vein quality independently of age. | I | C | - |
| Total arterial revascularization should be considered in patients with reasonable life expectancy. | IIa | B | 643 |
| Minimization of aortic manipulation is recommended. | I | B | 442,644 |
| Off-pump CABG should be considered for subgroups of high-risk patients in high-volume off-pump centres. | IIa | B | 626,627,629 |
| Off-pump CABG and/or no-touch on-pump techniques on the ascending aorta are recommended in patients with significant atherosclerotic disease of the ascending aorta in order to prevent perioperative stroke. | I | B | 443 |
| Minimally invasive CABG should be considered in patients with isolated LAD lesions. | IIa | C | |
| Electrocardiogram-triggered CT scans or epi-aortic scanning of the ascending aorta should be considered in patients over 70 years of age and/or with signs of extensive generalized atherosclerosis. | IIa | C | - |
| Routine intraoperative graft flow measurement should be considered. | IIa | C | - |

CABG = coronary artery bypass grafting; CT = computed tomography; IMA = internal mammary artery; LAD = left anterior descending.

^aClass of recommendation.

^bLevel of evidence.

^cReferences.

Off-pump CABG - On-pump CABG



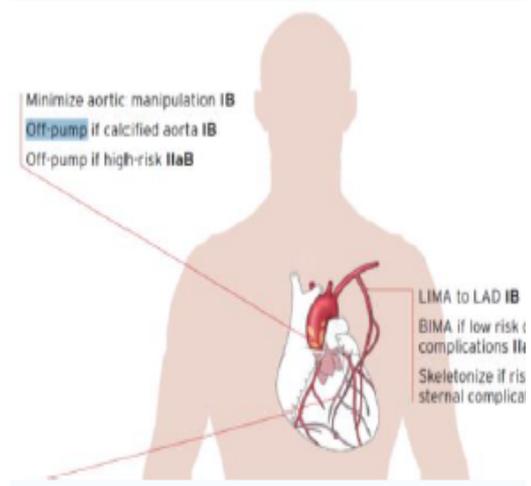

 European Journal of Cardio-Thoracic Surgery 00(2018) 1–87
 doi:10.1093/ejcts/ezy208

On this article see Sousa-Uva M, Meuwissen F J, Ahlsson A, Alfonso F, Banning AP, Benedetto U et al. 2018 ESC/EACTS Guidelines on myocardial revascularization. Eur J Cardiothorac Surg. 2018; doi:10.1093/ejcts/ezy208

2018 ESC/EACTS Guidelines on myocardial revascularization
The Task Force on myocardial revascularization of the European Society of Cardiology (ESC) and European Association for Cardio-Thoracic Surgery (EACTS)
 Developed with the special contribution of the European Association for Percutaneous Cardiovascular Interventions (EAPCI)

Authors/Task Force Members: Miguel Sousa-Uva¹ (EACTS Chairperson) (Portugal), Franz-Josef Neumann² (ESC Chairperson) (Germany), Anders Ahlsson³ (Sweden), Fernando Alfonso (Spain), Adrian P. Banning (UK), Umberto Benedetto⁴ (UK), Robert A. Byrne (Germany),

15.1.8 On-pump and off-pump procedures. Two large, international randomized trials have shown no difference in 30-day or 1-year clinical outcomes between on- and off-pump surgery when performed by experienced surgeons [518–520]. There is also evidence to conclude that, for most patients and surgeons, on-pump surgery provides excellent short- and long-term outcomes [518, 520–523]. For some surgeons, off-pump surgery is associated with inferior early and late graft patency rates, and possibly compromised long-term survival; however, aortic no-touch/clampless off-pump procedures in the hands of highly trained teams appear to be associated with a reduced risk of early morbidity, such as stroke, and fewer transfusions [508–510, 524–528]. In the subgroup of patients with end-stage CKD, there is some evidence that off-pump surgery is associated with lower in-hospital mortality and less need for new renal replacement therapy [529]. A summary of these technical aspects can be found in Figure 8.



| Minimally invasive techniques | | |
|--|-----|---|
| Off-pump CABG and preferably no-touch techniques on the ascending aorta by experienced operators, are recommended in patients with significant atherosclerotic aortic disease [508, 509, 544, 557–559]. | I | B |
| Off-pump CABG should be considered for subgroups of high-risk patients by experienced off-pump teams [525, 557–560]. | IIa | B |
| Where expertise exists, minimally invasive CABG through limited thoracic access should be considered in patients with isolated LAD lesions or in the context of hybrid revascularization [143, 534, 535, 561]. | IIa | B |
| Hybrid procedures, defined as consecutive or combined surgical and percutaneous revascularization, may be considered in specific patient subsets at experienced centres [536, 561–563]. | IIb | B |

CONSENSUS STATEMENT

ISMICS Consensus Conference and Statements of Randomized Controlled Trials of Off-Pump Versus Conventional Coronary Artery Bypass Surgery

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Stefano Benussi, MD,‡ Johannes O. Bonatti, MD,§ Anno Diegeler, MD,|| Francis D. Ferdinand, MD,¶
Teresa M. Kieser, MD,# André Lamy, MD,** Michael J. Mack, MD,†† Nirav C. Patel, MD,‡‡
Marc Ruel, MD,§§ Joseph F. Sabik, III, MD,|||| Bobby Yanagawa, MD, PhD,*
and Vipin Zamvar, MD¶¶*

(Innovations 2015;10:219-229)

ISMICS Consensus Conference and Statements

- A 2-day consensus conference was held, under the auspices of The International Society for Minimally Invasive Cardiothoracic Surgery (ISMICS).
- **12 highly experienced coronary surgeons proficient in both methods, 10 of whom perform primarily Off-pump CABG** (J.D.P., S.B., J.B.,A.D., F.D.F., T.K., A.L.,N.P., M.R.,V.Z.) and 3 of whom perform primarily On-pump CABG (M.M., J.B., and J.S.).
- All RCTs of Off-pump CABG versus On-pump CABG through April 2013 were screened, and **102 relevant RCTs (19,101 patients) were included in a systematic review and meta-analysis (15 RCTs of 9551 high-risk patients; and 87 RCTs of 9550 low-risk patients).**
- To be eligible for this meta-analysis, studies met the following criteria: patients were adults undergoing elective, urgent, or emergent CABG; allocation to **Off-pump CABG versus On-pump CABG was randomized**; at least one clinically relevant or resourcerelated outcome was reported; studies were published or unpublished, **in any language.**

ISMICS Consensus Conference and Statements

1. **Off-pump CABG and On-pump CABG** are not significantly different with regard to **30-day mortality**
2. **Off-pump CABG and On-pump CABG** are not significantly different with regard to **1-year mortality**
3. **Off-pump CABG** may be associated with increased **mortality beyond 1 year (median follow-up, 5 years)** compared to **On-pump CABG**
4. **Off-pump CABG** is associated with lower incidence **of stroke at 30 days** than **On-pump CABG**- **publication bias was present** (P = 0.04).
5. **Off-pump CABG and On-pump CABG** are not significantly different with regard to **stroke occurrence within 1 year - but may have been influenced by publication bias** (P = 0.05).
6. **Off-pump CABG and On-pump CABG** are not significantly different with regard to **30-day MI**.
7. **Off-pump CABG and On-pump CABG** are not significantly different with regard to **1-year MI**- there was a trend toward publication bias (P = 0.06).
8. **Off-pump CABG** is associated with significantly reduced **inotrope use** than **On-pump CABG**- **This finding was significantly influenced by heterogeneity (I2 = 61%) and publication bias** (P = 0.004).

Off-pump CABG - On-pump CABG

9. **Off-pump CABG** and **On-pump CABG** are not significantly different with regard to **perioperative intra-aortic balloon pump use**- **This finding was significantly influenced by heterogeneity (I2 = 60%), and there was a trend toward publication bias (P = 0.06).**
10. **Off-pump CABG** is associated with significantly reduced **postoperative AF** compared to **On-pump CABG** - **This finding was significantly influenced by heterogeneity (I2 = 72%), and there was a trend toward publication bias (P = 0.06).**
11. **Off-pump CABG** is associated with decreased incidence of **renal dysfunction or failure at 30 days** compared to **On-pump CABG**- **publication bias was present (P = 0.003).**
12. **Off-pump CABG** and **On-pump CABG** are not significantly different with regard to the need for **renal replacement therapy** - **publication bias was present (P = 0.05).**
13. **Off-pump CABG** and **On-pump CABG** are not significantly different with regard to the need for **chest re-exploration.**
14. **Off-pump CABG** is associated with lower rate of **RBC transfusion** than **On-pump CABG** - **This finding was significantly influenced by heterogeneity (I2 = 79%).**
15. **Off-pump CABG** is associated with lower incidence of **postoperative respiratory failure** (prolonged intubation or reintubation) than **On-pump CABG.**
16. **Off-pump CABG** is associated with fewer **wound complications** (sternal/harvest site) than **On-pump CABG.**
17. **Off-pump CABG** significantly reduces **procedure time** than **On-pump CABG**- **This finding was significantly influenced by heterogeneity (I2 = 93%Y98%) and publication bias (P = 0.006).**

Off-pump CABG - On-pump CABG

18. **Off-pump CABG** significantly reduces **ICU LOS – hospital LOS** was shorter after Off-pump CABG than **On-pump CABG** - **This finding was significantly influenced by heterogeneity.**
19. **Off-pump CABG** is associated with **fewer grafts** performed compared to **On-pump CABG**- **This finding was significantly influenced by heterogeneity.**
20. **Off-pump CABG and On-pump CABG** are not different with regard to **angina recurrence at maximum follow-up to 7 years.**
21. **Off-pump CABG** is associated with **higher incidence of graft occlusion** at 30 days or less than **On-pump CABG**
22. **Off-pump CABG and On-pump CABG** are not significantly different with regard to **30-day coronary reintervention (CABG/PCI).**
23. **Off-pump CABG** is associated with higher incidence of **coronary reintervention (CABG/PCI) at 1 year than On-pump CABG.**

ISMICS Consensus Conference and Statements

When compared to On-pump CABG in patients undergoing surgical coronary revascularization, it is reasonable to perform Off-pump CABG to reduce risk of

- stroke (class IIa, LOE A),
- renal dysfunction/failure (class IIa, LOE A),
- blood transfusion (class I, LOE A),
- respiratory failure (class I, LOE A),
- development of AF (class I, LOE A),
- wound infection (class I, LOE A), and
- to reduce ventilation times as well as ICU and hospital LOS (class I, LOE A).

However, Off-pump CABG may be associated with the risks of

- reduced number of grafts performed (class I, LOE A),
- reduced graft patency (class IIa, LOE A),
- increased coronary re-intervention at 1 year and beyond (class IIa, LOE A), and
- increased mortality at a median follow-up of 5 years (class IIb, LOE A).

ISMICS Consensus Conference and Statements

- Surgeon experience may play a more critical role in achieving optimal complete and precise revascularization during Off-pump CABG than On-pump CABG.
- The role of dedicated and present off-pump team should not be underestimated.
- Off-pump CABG compared with On-pump CABG may improve outcomes in the short-term (stroke, renal dysfunction, blood transfusion, respiratory failure, atrial fibrillation, wound infection, ventilation time, and length of stay). However, over the longer-term, Off-pump CABG may be associated with reduced graft patency, and increased risk of cardiac re-intervention and death.
- Review of the literature sounds a cautionary note indicating that sacrificing completeness or precision of revascularization to avoid cardiopulmonary bypass may lead to compromise of longer-term patient outcomes.
- Off-pump CABG offers lower short-term morbidity but poorer long-term survival. These results suggest that, in real-world settings, greater operative safety with off-pump CABG comes at the expense of lasting survival gains.

Chikwe J, Lee T, Itagaki S, et al. [Long-term outcomes after off-pump versus on-pump coronary artery bypass grafting by experienced surgeons.](#) *J Am Coll Cardiol.* 2018;72:1478-1486.

NEWS IN INTERVENTIONAL

Long-term Off-Pump CABG Results Deflate in Large, Real-world Study

The findings indicate that off-pump patients have less complete revascularization than on-pump patients and are more likely to die.

BY L.A. MCKEOWN | SEPTEMBER 20, 2018



As time goes by, patients treated with off-pump CABG surgery have higher mortality, less complete revascularization, and more need for repeat revascularization in the ensuing years than those treated with an on-pump approach, new real-world data suggest.

“Both techniques have great short-term results, that is not in any doubt, but for maximum long-term benefit it seems that on-pump surgery is the route to take.”

!!! The median number of CABGs completed by these surgeons at the time of the index procedure was 905 for off-pump CABG, and 953 for on-pump CABG, respectively, with a median of 79 off-pump and 137 on-pump CABG cases completed during the 365 days immediately before surgery.

<https://www.tctmd.com/news/long-term-pump-cabg-results-deflate-large-real-world-study>

Different Point of View on Minimal Invasive Heart Surgery: Minimal Extra-Corporeal Circulation (MECC)

Characteristics of MECC

- Closed circuit (without having reservoir)
- Centrifugal pump
- Short tubings
- Biocompatible surface cover
- Less priming- thus less hemodilution
- Miniaturised cardioplegia



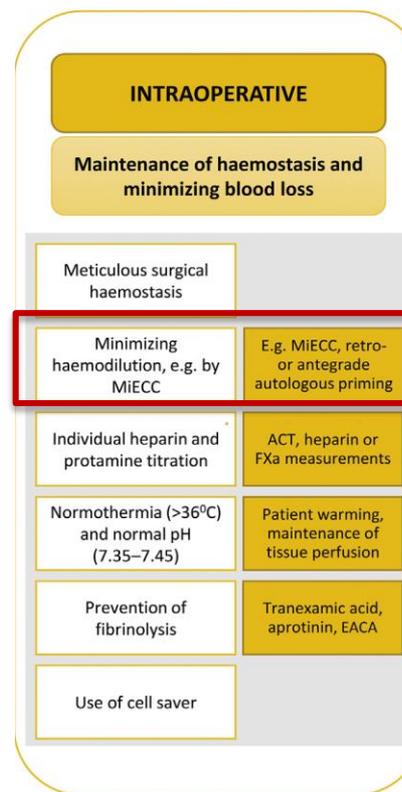
Different Point of View on Minimal Invasive Heart Surgery: Minimal Extra-Corporeal Circulation (MECC)

Advantages of MECC

- Reduction of hemodilution
- Absence of air/blood contact
- Absence direct – voluminous aspiration of the blood
- Better preservation of coagulation
- Decreased SIRS reaction

2017 EACTS/EACTA Guidelines on patient blood management for adult cardiac surgery

The Task Force on Patient Blood Management for Adult Cardiac Surgery of the European Association for Cardio-Thoracic Surgery (EACTS) and the European Association of Cardiothoracic Anaesthesiology (EACTA)



Different Point of View on Minimal Invasive Heart Surgery: Minimal Extra-Corporeal Circulation (MECC)

Cardioplexol—Characteristics

- Volume of 100 ml
- Single bolus injection (no need for additional equipment, no repetition)
- Immediate cardiac arrest (< 10 seconds)
- Prolonged effect (45 minutes)
- Ready to use (shelf life of 24 months at room temperature)
- 14 years of clinical experience, > 8500 patients by multiple centers in 10 European countries (Switzerland, Germany, Spain, Italy, Austria, France, Belgium, Poland, Russia, NL)



Different Point of View on Minimal Invasive Heart Surgery: Minimal Extra-Corporeal Circulation (MECC)

Cardioplexol–Characteristics

- Solution A (95 ml):

Kalium: induction of diastolic cardiac arrest

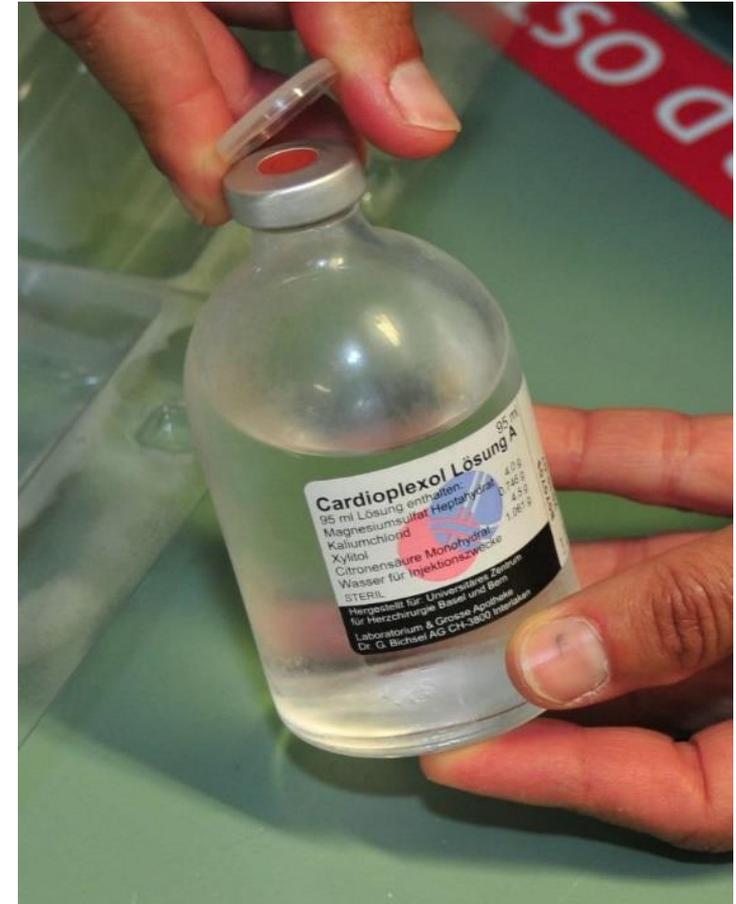
Magnesium: membrane stabilizer, reduce Ca⁺ loading

Xylitol: edema prevention

- Solution B (5 ml): -Procain

Procain: induction of cardiac arrest and membrane stabilizer

- Storage at room temperature
- Solutions A and B are mixed immediately before use)



Another Perspective On Minimally Invasive Coronary Bypass Surgery: A Comparative Study

Dr. Archana Gopalakrishnan

AIM: The aim of this study is to compare the outcomes of patients who underwent coronary artery bypass grafting (CABG) by using three different operative strategies: conventional extracorporeal circulation (ECC), minimal extracorporeal circulation (MECC) and beating heart surgery (OPCAB).

METHODS: Data was retrospectively collected for 213 patients (ECC n=118, MECC n=62, OPCAB n=33) who underwent elective CABGs between May 2013 and May 2018 in our institution. Demographic and pre-operative data were studied. Peri- and acute post-operative results were analysed as primary outcomes.

| | Total sample (N=213) | ECC (N=118) | MECC (N=62) | OPCAB (N=33) | P-value |
|----------------------------|---|--------------|--------------|---------------|---------|
| Sex, n (%) | | | | | 0.346 |
| Male | 187 (87.8) | 103 (87.3) | 57 (91.9) | 27 (81.8) | |
| Female | 26 (12.2) | 15 (12.7) | 5 (8.1) | 6 (18.2) | |
| Age, mean (SD) | 63.87 (9.28) | 64.15 (9.19) | 62.71 (8.68) | 65.03 (10.65) | 0.453 |
| Body mass index, mean (SD) | 27.63 (4.41) | 27.57 (4.22) | 27.35 (4.81) | 28.42 (4.34) | 0.522 |
| Risk factors, n (%) | Obesity, hypertension, dyslipidemia, diabetes, smoker | | | | > 0.05 |
| Personal history, n (%) | Nothing, myocardial infarction, stent, stroke, cardiac arrest | | | | > 0.05 |

Another Perspective On Minimally Invasive Coronary Bypass Surgery: A Comparative Study

Dr. Archana Gopalakrishnan

RESULTS: Demographic data, risk factors and pre-operative data were similar between the three groups. **The patients who underwent OPCAB had fewer bypasses, fewer venous grafts, as well as less lactate production than ECC and MECC (Table 1). The patients in the ECC group had more peri-operative transfusions than MECC and OPCAB and differed from only MECC with a higher inotropic score at 6 hours after ICU admission, more creatinine production and a bigger volume of drainage in the ICU (Table 1). There is no difference concerning post-operative complications between the three groups.**

| | Total (N=213) | ECC (N=118) | MECC (N=62) | OPCAB (N=33) | P-value |
|--------------------------------------|---------------|-------------|-------------|--------------|----------|
| Number of bypasses, mean (SD) | 2.77 (0.81) | 2.86 (0.75) | 2.94 (0.83) | 2.15 (0.67) | < 0.001* |
| Number of venous bypasses, mean (SD) | 1.00 (0.81) | 1.08 (0.81) | 1.16 (0.82) | 0.39 (0.50) | < 0.001* |

Post-hoc analysis of the above variables :

Number of bypasses : significant difference between MECC-OPCAB and ECC-OPCAB
Number of venous bypasses : significant difference between MECC-OPCAB and ECC-OPCAB

Minimal Extracorporeal Circulation –

Another Perspective On Minimally Invasive Coronary Bypass Surgery: A Comparative Study

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RESULTS: The patients who underwent OPCAB had fewer bypasses, fewer venous grafts, as well as less lactate production than ECC and MECC (Table 1). The patients in the ECC group had more peri-operative transfusions than MECC and OPCAB and differed from only MECC with a higher inotropic score at 6 hours after ICU admission, more creatinine production and a bigger volume of drainage in the ICU (Table 1). There is no difference concerning post-operative complications between the three groups.

| | Total sample (N=213) | ECC (N=118) | MECC (N=62) | OPCAB (N=33) | P-value |
|---|-------------------------|--------------------|--------------------|--------------------|---------|
| Lactate index (log), mean (SD) (= 24-hour lactates / lactates at ICU admission) | 0.043 (0.203) | 0.059 (0.196) | 0.064 (0.182) | -0.055 (0.242) | 0.01* |
| Creatinine index (log), mean (SD) (= 24-hour creatinine / pre-operative creatinine) | -0.041 (0.106) | -0.024 (0.096) | -0.074 (0.074) | -0.036 (0.164) | 0.002* |
| Inotropic score 6 hours, mean (SD) (N=42) | 360.15 (347.16) | 604.32 (383.04) | 241.92 (294.68) | 409.60 (309.97) | 0.009* |
| Total drainage ICU (log), mean (SD) | 2.969 (0.342) | 3.045 (0.311) | 2.865 (0.336) | 2.894 (0.398) | 0.001* |

Post-hoc analysis of the above variables :

Lactate index : significant difference between MECC-OPCAB and ECC-OPCAB

Creatinine index : significant difference between ECC-MECC

Inotropic score 6 hours : significant difference between ECC-MECC

Total drainage ICU : significant difference between ECC-MECC

Another Perspective On Minimally Invasive Coronary Bypass Surgery: A Comparative Study

Dr. Archana Gopalakrishnan

The patients who underwent CABG

- **with ECC** had increased peri-operative transfusions compared to MECC and OPCAB, and increased post-operative creatinine production, higher inotropic score at 6 hours and more total drainage compared to MECC;
- **with off-pump technique (OPCAB)** had fewer bypass grafts, fewer venous conduits and decreased post-operative lactate production compared to ECC and MECC.

!!! MECC could prove to be a good alternative to both OPCAB and ECC by combining the advantages of both aforementioned methods.

Limitations of the study : Small sample size of 213 patients and the non-equivalent group sizes.

Take Home Message

- The potential harms of cardiopulmonary bypass during on-pump CABG seems to be minimal in low risk patients and compared to the higher degree of technical precision, anastomotic quality, and completeness of revascularization, this should not be jeopardized in order to avoid CPB.
- On-pump techniques are associated with increased risk of peri-operative adverse events in "high risk" patients, while off-pump is associated with increased risk of long-term adverse events in "low risk" patients.
- Although the controversy about on-pump versus off-pump CABG is likely to continue, it is time to change the discussion and choose the procedure that is best for the patient.
- MECC could prove to be a good alternative to both OPCAB and ECC by combining the advantages of both aforementioned methods.



THANK YOU

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