On Pump vs Off Pump

ΓΙΩΡΓΟΣ Λ. ΛΑΖΟΠΟΥΛΟΣ
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1876: Adam Hammer establishes that angina pain could be attributed to interruption of coronary blood supply and that heart attacks occurred when at least one coronary artery is blocked.

1910: As the culmination of animal and human development efforts, Alexis Carrell presents paper to American Surgical Association describing coronary artery bypass.
INTERNAL MAMMARY CORONARY ANASTOMOSIS IN THE SURGICAL TREATMENT OF CORONARY ARTERY INSUFFICIENCY

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This paper constitutes a preliminary report of clinical cases which have undergone transplantation of the left internal mammary artery into the left ventricle as a treatment for coronary artery insufficiency. The theoretical and experimental basis on which this procedure is based will be briefly described.

Fig. 1 Arthur M. Vineberg (1903-1988)


Unilateral Vineberg Arterial Graft With a Patency of 30 Years

Thomas Krabatsch, MD; Onnen Grauhan, MD, PhD; Roland Hetzer, MD, PhD
When Kolesov's initial experience was first published in English in 1967, it was accompanied by the following editorial foreword:

“The opinions concerning the management and surgical treatment of angina pectoris as expressed in this paper by Professor V.I. Kolesov are at variance with the concepts of many surgeons in the United States.”

Ironically, the initial attitude toward his work was even worse in his home country. In June of 1967, Kolesov presented the results of the ITA-to-coronary artery grafting at the meeting of the Cardiology Society in Leningrad. The plenum of the Society accepted the following resolution: “the surgical treatment of coronary artery disease is impossible and has not prospects for the future.”
Dr. John H. Gibbon, Βοστώνη, 6 Μαΐου 1953
1973: Benetti, Calafiore, Subramian achieve direct anastamoses between LIMA and LAD on beating hearts, operating through 10 cm incisions between ribs.

1995: The medical products industry, with significant venture capital support, launches innovative products to enable coronary revascularization on a beating heart via a median sternotomy without an external perfusion circuit or through intercostal ports while using the perfusion circuit. This stimulated development of techniques and products designed to minimize the risk associated with cardiac surgical procedures.

1997: In partnership with a team led by Cornelius Borst at the University of Utrecht, Medtronic Inc., introduces one of the industry’s first tissue stabilizers, the Octopus®, which utilizes suction technology to stabilize the coronary target for off-pump revascularization. Significant adoption of this technology, which avoids use of the external perfusion circuit, stimulates interest among surgeons and cardiologists in the benefits of off-pump revascularization of the beating heart.
On Pump vs Off Pump

• The attraction of off pump CABG is a reduction in the inflammatory response in combination with minimal aortic manipulation and avoidance of aortic cannulation, which may reduce the risk of stroke.

• However, many surgeons would argue that cardioplegic arrest provides the best conditions for optimal revascularisation.

• The debate as to which method is superior has been ongoing for the past 25 years.
Off pump CABG is:

- widely performed
- safe
- effective
- and there are numerous techniques available: limited thoracotomy, video assisted.

On pump CABG offers a balance between:

- an easy, bloodless surgical field,
- with the risks of bypass and embolic events from clamping and cannulating the aorta.

Off pump CABG is generally preferred in:

- patients with aortic disease
- patients at higher risk of complications from CPB such as:
  - ventricular dysfunction,
  - renal insufficiency,
  - diabetes,
  - advanced age,
  - chronic lung disease
Off Pump

ADVANTAGES

• avoids bypass
• no aortic cannulation -> less risk of dissection, embolism
• no atrial cannulation -> less atrial injury, arrhythmias
• no cross-clamping -> less risk of plaque embolism, CVA, MI
• no activation of coagulation, kallikrein, inflammation caused by tubing -> less coagulopathy, less bleeding, less transfusion
• no cardioplegia -> no K+ load, fluid load, coronary air embolism
• no risk of bypass machine failure -> air embolism
• less cost - less equipment - less staff

DISADVANTAGES

• needs skilled staff
• technically more difficult (increased risk of anastomotic bleeding, suboptimal revascularisation, myocardial ischaemia
• not all coronary arteries well reached by technique - incomplete revascularisation more frequent
• potential for MI without cardioplegia
• more graft failure
• more difficult in diffuse disease or small artery disease
Conclusions: Off-pump coronary surgery significantly lowers in-hospital morbidity without compromising outcome in the first 1–3 years after surgery compared with conventional on-pump coronary surgery.

Conclusions: OPCABG results in significantly better left ventricular function early after surgery but does not reduce the incidence or extent of irreversible myocardial injury.
Conclusions: Off-pump CABG with multiple arterial grafts was as safe as the conventional on-pump CABG, with similar completeness of revascularization and early graft patency.

Conclusions: The patency of arterial coronary bypass grafts done on the beating heart is excellent and equal to grafts done on pump. The off-pump procedure in the unselected patient population results in fewer patent saphenous grafts per patient.
Conclusions: OPCAB is associated with a significant reduction in the odds of cerebral stroke compared with conventional CABG. In addition, benefits of OPCAB in terms of death, MI, and cerebral stroke are significantly related to patient risk profile, suggesting that OPCAB should be strongly considered in high-risk patients.
On Pump vs off Pump

• The popularity of “off-pump” CABG **peaked in 2002**, when it constituted approximately **23%** of CABG procedures

  and then

• declined to **17%** by **2012**.
Scepticism


Myocardial revascularization without extracorporeal circulation; Why hasn't it convinced yet?

Apostolakis E¹, Papakonstantinou NA², Koniari I³.
• Quality-quantity of Distal Anastomoses
• In-hospital Mortality
• Blood loss
• Myocardial injury
• Atrial fibrillation
• Neurological and neurocognitive damage
• Renal impairment
• Left ventricle ejection fraction
• Intensive Care Unit and Hospital Stay Duration
• Mid and Long-term Outcomes
• Conversion Rate
• Quality of Life
• Cost Comparison
The four largest trials to date are:

- **CORONARY** (n=2,375 off vs. 2,377 on) (79 hospitals, 19 countries)
- **DOORS** (n=450 off vs. 450 on) Danish on-pump vs off-pump randomization study
- **GOPCABE** (n=1,271 off vs. 1,268 on) The German Off-Pump CABG in Elderly Patients Study
- **ROOBY** (n=1,104 off vs. 1,099 on) Veterans Affairs Randomized On/Off Bypass trial
30 days after surgery:

- **Death or stroke:** None of the studies showed significant difference between on and off pump.
- **Myocardial infarction:** No significant difference.
- **Repeat revascularisation:** CORONARY and GOPCABE showed a significantly higher early need for repeat revascularisation in the off pump group. (No difference in the ROOBY-trial).

In short none of these major studies showed a difference in hard clinical outcomes between the off and on pump groups at 30 days.
Conclusions: At 1 year after CABG, there was no significant difference between off-pump and on-pump CABG with respect to the primary composite outcome, the rate of repeat coronary revascularization, quality of life, or neurocognitive function.
**Conclusions:** At 1 year of follow-up, patients in the off-pump group had worse composite outcomes and poorer graft patency than did patients in the on-pump group.

No significant differences between the techniques were found in neuropsychological outcomes or use of major resources.
Conclusions: In patients 75 years of age or older, there was no significant difference between on- and off-pump CABG with regard to the composite outcome of death, stroke, myocardial infarction, repeat revascularization, or new renal-replacement therapy within 30 days and within 12 months after surgery.

‘Considering the high incidence of coexisting conditions in this population, we anticipated that this trial would clarify the potential benefit of off-pump CABG in high-risk patients.’
Conclusions: Both on- and off-pump CABG are safe procedures that improved the quality of life when performed in elderly patients. No major differences in intermediate-term outcomes were found.

However, the noninferiority of OPCAB with the prespecified margin could not be confirmed.

Conclusions: The rate of the composite outcome of death, stroke, myocardial infarction, renal failure, or repeat revascularization at 5 years of follow-up was similar among patients who underwent off-pump CABG and those who underwent on-pump CABG.
Conclusions: Off-pump CABG led to lower rates of 5-year survival and event-free survival than on-pump CABG.
Conclusions:

• The ROOBY trial showed that at 1 year and 5-years, those in the off-pump group had worse composite outcomes, poorer graft patency, and greater incidence of incomplete revascularization than the on-pump group.

• However, the use of off-pump CABG was vindicated in two other trials—CORONARY and GOPCABE—in which experienced surgeons in high-volume centers with high-risk patients had no difference in outcomes at 1 and 5 years.
Conclusions:

• The recommendation is to tailor the procedure to the patient rather than the patient to the procedure.

• The decision, as to whether to operate off- or on-pump, may simply come down to the individual surgeon’s preference.

  Aorta ?
  Number of Grafts needed ?
  Ejection fraction ?
  Age ?
  Surgical skills ?
ΠΡΟΣ ΠΑΡΑΛΙΑ
PATH TO THE BEACH