

Coronary artery bypass grafting off-pump or on-pump: another brick in the wall

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Off-pump coronary bypass grafting (OPCAB) was reintroduced in the early 90's to limit what was perceived the drawbacks of the cardiopulmonary bypass (CPB). The development of left anterior descending artery via a left anterior small thoracotomy (1) increased the interest in myocardial revascularization via a median sternotomy as an important strategy to limit the use of CPB. The first years of the surgical experience were dominated by observational studies aimed to evaluate more the technical aspects and the advantages of OPCAB versus on-pump coronary artery bypass (ONCAB). We have to take into account that exposure of the lateral wall was difficult if not impossible at the early beginning. Our group first described a technique to safely graft the branches of the circumflex artery and of the right coronary artery (2). As a second step, introduction of the stabilizers and of the apical suctions by different Companies improved the exposure and stability of the operative field, representing a great result of the collaboration between Companies and Surgeons.

The quality of observational studies was improved by propensity matching (PM), but, in the same time, many randomized controlled trials (RCT) were started, often bringing to completely different outcome. In general, the real problem was that PM studies included all patients, independently from the risk, whereas the RCT had a trend to include patients with low or medium risk, making difficult to understand the right prospective to be given their conclusions. The general feeling was, however, that

OPCAB was in most of the cases related to a worse early and late outcome of the patients. As a consequence, there was, during the last years, a progressive decline in OPCAB, at least in United States (3).

In the recent years more other papers appeared, more balanced in their conclusions, with the aim to provide a more reasonable vision of the limits and the benefits of both strategies. The paper by Kirmani *et al.* (4) includes 15 years of surgical experience and analyzes the long term survival and the incidence of reoperation in on- and off-pump patients. Analyzing two groups of 5,539 PM patients each, they found that long term survival and survival without coronary reintervention was similar regardless the surgical strategy used, on- or off-pump. This paper is important for the rigorous statistical method used by the Authors, for the high number of patients and for the follow up length. The message sent is on line with the more recent trend of the literature: OPCAB, if correctly performed, can have no different outcome respect to the ONCAB. Nonetheless, many issues still divide the scientific world, some of which not yet solved.

One of the most important benefits of OPCAB was considered to be a reduction of early mortality and, consequently, an increase of late survival. In general, RCTs showed constantly similar early mortality in OPCAB and in ONCAB, both in the elderly (5) and in the general population (6,7). However, mortality reduction in the first month has been reported by some PM studies (8), as well

by meta analyses (9) and large data bases, but not in all reports (10). There was a trend in favor of OPCAB in high risk patients, but it was not constant. In high risk patients, variously defined, mortality was reported to be lower (11), but this finding was not confirmed by others (12). In general, we can say that mortality reduction is not a goal that we have to pursue by means of the OPCAB, as it has the variable “conversion” which can be unpredictable. Conversion is a major drawback so far unsolved. Kirmani *et al.* (4) in their report had a prevalence of 1.3%, but with a mortality of 10.5%. In many series conversion rate has been over 10%. Not only mortality is higher, reaching even 16.5% (13), but conversion causes organ damages that increase enormously postoperative morbidity as well as stroke. Risk factors are various, as presence of mitral regurgitation, pulmonary hypertension, preoperative heart failure, ongoing acute myocardial infarction, left main disease, diffuse coronary disease and so on.

One of the most important, and popularized, benefit of OPCAB was reduction of early stroke (8,11). Our group emphasized the relationship between aortic manipulation and stroke incidence (14). Nevertheless, this finding was not confirmed by other studies, where no difference was found (5-7,15). However, we must say that there is no study able to demonstrate that OPCAB has a stroke rate higher than ONCAB. Remaining in the neurological domain, the cognitive impairment related to myocardial revascularization was found to be similar, regardless the surgical strategy applied, in many studies as well (7).

One of OPCAB Achille's heels is the reduced patency rate reported by many authors. Khan *et al.* (16) in a RCT reported a lower patency rate after 3 months from surgery and this finding was confirmed by others (17). In general patients undergoing OPCAB have less grafts, higher incidence of incomplete revascularization and higher revascularization rate (5,6). Even if the lower number of graft can be due not to a real reduction with OPCAB but to an excess of grafting with ONCAB, it is out of discussion that the future of our patients depends on the graft patency, which is on the effectiveness of our myocardial revascularization. It is then difficult to expect, even in the best hands, a better survival in OPCAB compared to the ONCAB patients. Many papers showed worse survival with OPCAB (18), even if in other studies similar survival was reported (5,19). In general, no study showed a better survival with OPCAB.

In this context of conflicting results, the paper from Kirmani *et al.* (4) allows us to evaluate the long-term

experience of a center dedicated to find the best surgical solution for their patients. Is it possible to draw conclusions from this conflicting data? If we have to find the best candidate for OPCAB, it is not an easy task. In the early phase it is possible to reduce some of the secondary end points, as length of ICU stay, less ventilation time or transfusions, but not the primary ones, as mortality, acute myocardial infarction or stroke. On the other side we have to say that a lot of improvements have been achieved for on-pump surgery. Cardiopulmonary bypass is less traumatic, priming has been strongly reduced and the quality of the oxygenators improved. The wide diffusion of ascending aorta scanning eliminated aortic manipulation in patients with diseased aorta, reducing actively, or eliminating, the incidence of perioperative stroke. As a global result, it has been reported that in-hospital mortality reduced in US from 2.7% in 2008 to 2.2% in 2012, whereas the burden of comorbidity increased (20) and the incidence of OPCAB decreased (3). Most of the postoperative complications, with the exception of bleeding, reduced as well. There is not a specific role for OPCAB. As all surgical technique, OPCAB can be applied to any patient who has the proper indications, in particular the lowest risk possible for conversion. What is important is not how to revascularize the patient. Use of the cardiopulmonary bypass is a false problem, as any surgeon has to decide according to his personal beliefs and his personal skill. What is important is to apply the rules we know to obtain the best long term result possible: complete revascularization, use of arterial conduits (both thoracic arteries when possible) and good quality anastomoses. The study of Kirmani *et al.* (4) is able to demonstrate that, in the real world, is possible to achieve the best results possible with good patients' selections.

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Footnote

Conflicts of Interest: The authors have no conflicts of interest to declare.

References

1. Calafiore AM, Giammarco GD, Teodori G, et al. Left anterior descending coronary artery grafting via left anterior small thoracotomy without cardiopulmonary

- bypass. *Ann Thorac Surg* 1996;61:1658-63.
2. Calafiore AM, Teodori G, Di Giammarco G, et al. Multiple arterial conduits without cardiopulmonary bypass: early angiographic results. *Ann Thorac Surg* 1999;67:450-6.
 3. Bakaeen FG, Shroyer AL, Gammie JS, et al. Trends in use of off-pump coronary artery bypass grafting: Results from the Society of Thoracic Surgeons Adult Cardiac Surgery Database. *J Thorac Cardiovasc Surg* 2014;148:856-3.
 4. Kirmani BH, Holmes MV, Muir AD. Long-term survival and freedom from reintervention after off-pump coronary artery bypass grafting: a propensity-matched study. *Circulation* 2016;134:1209-20.
 5. Diegeler A, Borgermann J, Kappert U, et al. Off-pump versus on-pump coronary-artery bypass grafting in elderly patients. *N Engl J Med* 2013;368:1189-98.
 6. Lamy A, Devereaux PJ, Prabhakaran D, et al. Off-pump or on-pump coronary-artery bypass grafting at 30 days. *N Engl J Med* 2012;366:1489-97.
 7. Shroyer AL, Grover FL, Hattler B, et al. On-pump versus off-pump coronary-artery bypass surgery. *N Engl J Med* 2009;361:1827-37.
 8. Kuss O, von Salviati B, Borgermann J. Off-pump versus on-pump coronary artery bypass grafting: a systematic review and meta-analysis of propensity score analyses. *J Thorac Cardiovasc Surg* 2010;140:829-35.
 9. Altarabsheh SE, Deo SV, Rababa'h AM, et al. Off-pump coronary artery bypass reduces early stroke in octogenarians: a meta-analysis of 18,000 patients. *Ann Thorac Surg* 2015;99:1568-75.
 10. Chu D, Bakaeen FG, Dao TK, LeMaire SA, Coselli JS, Huh J. On-pump versus off-pump coronary artery bypass grafting in a cohort of 63,000 patients. *Ann Thorac Surg* 2009;87:1820-6.
 11. Kowalewski M, Pawliszak W, Malvindi PG, et al. Off-pump coronary artery bypass grafting improves short-term outcomes in high-risk patients compared with on-pump coronary artery bypass grafting: Meta-analysis. *J Thorac Cardiovasc Surg* 2016;151:60-77.
 12. Chen JJ, Lin LY, Yang YH, et al. On pump versus off pump coronary artery bypass grafting in patients with end-stage renal disease and coronary artery disease - A nationwide, propensity score matched database analyses. *Int J Cardiol* 2017;227:529-34.
 13. Borde DP, Asegaonkar B, Apsingekar P, et al. Intraoperative conversion to on-pump coronary artery bypass grafting is independently associated with higher mortality in patients undergoing off-pump coronary artery bypass grafting: A propensity-matched analysis. *Ann Card Anaesth* 2016;19:475-80.
 14. Calafiore AM, Di Mauro M, Teodori G, et al. Impact of aortic manipulation on incidence of cerebrovascular accidents after surgical myocardial revascularization. *Ann Thorac Surg* 2002;73:1387-93.
 15. Taggart DP, Altman DG, Gray AM, et al. Effects of on-pump and off-pump surgery in the Arterial Revascularization Trial. *Eur J Cardiothorac Surg* 2015;47:1059-65.
 16. Khan NE, De Souza A, Mister R, et al. A randomized comparison of off-pump and on-pump multivessel coronary-artery bypass surgery. *N Engl J Med* 2004;350:21-8.
 17. Deppe AC, Arbash W, Kuhn EW, et al. Current evidence of coronary artery bypass grafting off-pump versus on-pump: a systematic review with meta-analysis of over 16,900 patients investigated in randomized controlled trials. *Eur J Cardiothorac Surg* 2016;49:1031-41.
 18. Takagi H, Matsui M, Umemoto T. Off-pump coronary artery bypass may increase late mortality: a meta-analysis of randomized trials. *Ann Thorac Surg* 2010;89:1881-8.
 19. Lamy A, Devereaux PJ, Prabhakaran D, et al. Five-Year Outcomes after Off-Pump or On-Pump Coronary-Artery Bypass Grafting. *N Engl J Med* 2016;375:2359-68.
 20. Moazzami K, Dolmatova E, Maher J, et al. In-Hospital Outcomes and Complications of Coronary Artery Bypass Grafting in the United States Between 2008 and 2012. *J Cardiothorac Vasc Anesth* 2017;31:19-25.

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