

# On-and off-pump coronary artery bypass surgery. The heart surgeon should master both techniques

*Cirurgia de revascularização miocárdica com e sem circulação extracorpórea. O cirurgião cardíaco deve dominar ambas as técnicas*

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Coronary artery bypass grafting (CABG) has reinforced its importance in the treatment of coronary artery disease (CAD) with the latest scientific evidence, proving to be the most effective in improving patient outcomes when compared to other therapies, such as drug or interventionist, especially in high risk patients. However, controversy remains as to the technique to be employed, particularly with regard to employment or not of cardiopulmonary bypass (CPB).

The OPCABG emerged as an alternative technique to avoid the deleterious effects of CPB, which negatively affect the outcome of MRI, notably the systemic inflammatory response syndrome, which leads to complications, inducing organ dysfunction, and the need for cannulation and aortic clamping which increases the incidence of cerebrovascular accident (CVA). With the increasing complexity of cases referred for surgery, these complications can compromise the expected result and the implicit benefit for patients, especially those with higher morbidity and older.

However, OPCAB surgery has been questioned regarding its efficacy and safety in comparison to the conventional technique, especially with the outcomes related to incomplete revascularization and quality of grafts.

In this issue of BJCVS, the findings of the study by

Cerqueira Neto et al. [1] [pg. 283] reinforce that the quality of the anastomosis of the left internal thoracic artery (LITA) to left anterior descending artery (LAD) is similar, with fluxometric data showing no difference between them, either performed with or without CPB. Unfortunately, there was no comparison with the grafts to other areas of the heart, what would allow additional information and verifying that the results also apply. However, the anastomosis of the LITA to LAD stands today as the only strategy in CABG surgery that increases survival.

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The quality of anastomosis in off-pump surgery is implicitly related to surgeon experience. While experienced surgeons performing the technique reported the same degree of patency of the techniques over 8 years of follow-up [2,3] in assays in which less experienced surgeons operated, the results were inferior and high intraoperative conversion rates as described in the Rooby study [4]. Similarly, while more experienced surgeons tend to perform more complete revascularization, other surgeons reported low outcomes.

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Meta-analyzes that compared the two strategies have shown similar results, with a tendency to favor survival and other outcomes in OPCAB [5], although other studies have shown negative results. The Rooby study demonstrated worse prognosis with this technique and a published meta-analysis suggested a higher mortality rate with off-pump technique [6].

The most recent published meta-analysis examined 59 trials, comprising 8966 patients and showed that off-pump surgery reduces the incidence of stroke by 30% compared to the conventional technique, with no difference in the outcomes of 30-day mortality and perioperative infarction, which were not affected by age, gender and number of grafts [7].

The concept of incomplete revascularization has been changing and new knowledge brought have changed this dogmatic and stereotyped plea, whose different settings involved in controversies about results in the medium and long term.

Although complete revascularization is considered superior to incomplete revascularization, with better survival and lower reintervention in the long term, it is not yet clear whether this difference is a direct consequence of incomplete revascularization or if this approach is merely a marker of more severe coronary disease and complex with more rapid progression. Currently, it is discussed if indeed incomplete revascularization may negatively affect long-term outcome or may be the optimal treatment strategy in selected cases of high-risk patients, minimizing risk of perioperative mortality and morbidity and possibly allowing a safer revascularization.

Thus, the analysis of the follow-up of 5 years of MASS III study comparing 308 patients undergone surgery with and without CPB, showed that the number of grafts per patient was higher in the on-pump group than in the off-pump group (2.97 vs. 2, 49,  $P < 0.001$ ), but no difference between groups in long-term outcomes (death, myocardial infarction, new revascularization or stroke). [8] In the BARI trial, complete or incomplete revascularization had no impact on results in 7 years follow-up of patients [9].

Likewise, data from three years of the SYNTAX trial reported the incidence and predictors of incomplete revascularization after percutaneous coronary intervention (PCI) or CABG, while incomplete revascularization was associated with adverse events after PCI, and compared to MRI there was no difference between groups. The rate of incomplete revascularization was 43% for PCI and 37% for MRI, reinforcing that the incidence of incomplete revascularization was higher in patients with more complex coronary artery disease, as patients enrolled in SYNTAX, reflecting our current practice [10].

In the study group of Leipzig, in a cohort of 8806 patients undergoing CABG with multivessel disease in which

approximately 10% had incomplete revascularization (within the circumflex artery and the right coronary artery, but with all the LITA grafted to the LAD) there was no difference in survival at 3 years follow-up compared to those with complete revascularization. The incomplete revascularization was five times more frequent in patients with more complex coronary heart disease. The authors conclude that, in the presence of LITA grafted to the LAD and other arteries (circumflex and right coronary) of poor quality, incomplete revascularization did not affect survival in the short or long term and may be a good therapeutic option and should be balanced with the risks [11].

The anatomical criteria (SYNTAX score) and ischemic functional tests have been challenged in the estimation of the risk profile in incomplete revascularization. The FAME study randomized 1005 patients with multivessel CAD to complete anatomic revascularization (PCI in vessels of adequate size, with stenoses of 50% to 100%) against physiological incomplete revascularization based on fractional flow reserve  $< 0.80$ . The anatomically incomplete revascularization, but configuring a complete ischemic revascularization resulted in a 34% lower relative risk of death or myocardial infarction at one year [12].

The CORONARY study, the largest prospective randomized trial performed so far comparing strategies for CABG with and without CPB, reported the results of 30 days involving 4752 patients and showed no significant difference in the primary composite endpoint (death, myocardial infarction, stroke or renal failure requiring dialysis) between the two techniques. The off-pump group showed a lower incidence of acute renal failure, reducing the duration of mechanical ventilation and the incidence of reoperation for bleeding, and lower rates of blood transfusions and decreased respiratory complications. However, there were fewer grafts and increased risk of repeated revascularization. Interestingly, for the composite endpoint in this study, patients operated in South America had statistically better with OPCAB than with CPB [13].

The DOORS study randomized 900 patients elderly ( $> 70$  years) for CABG with and without CPB, including surgeons with intermediate experience in off-pump surgery. Results at 30 days showed no statistical difference between the two techniques, the composite endpoint of death, MI and stroke [14].

The guidelines for revascularization of the European Society of Cardiology 2010 and the American societies published in 2011 reinforce the indications for use of off-pump CABG in selected patients and with greater severity. They recommend OPCAB in patients with mild to moderate chronic renal insufficiency, with calcified aorta and consequent increased risk of intraoperative stroke (in this case, the technique of no-touch aorta is specifically recommended), after angioplasty without success and also

in patients with coagulation disorders, where without using CPB may benefit the patient [15,16].

Likewise, in 2011, the National Institute for Health and Clinical Excellence (NICE) has issued a document update in OPCAB surgery, which, after review of the published evidence, which reinforces that the safety and effectiveness are adequate to support its use, since the conditions for clinical use are provided, patient consent and data audit. The NICE document emphasizes that OPCAB may also be particularly useful in patients with left ventricular dysfunction, advanced aortic atherosclerosis and the elderly [17].

It should be emphasized that the property of off-pump CABG in reducing stroke event is related to surgical technique, which effectively only the no-touch technique of the ascending aorta reduces the risk of neurological damage. The multiple manipulations of the ascending aorta required by conventional surgery promote atheromatous embolization, providing the probable mechanism for the increased risk of stroke. Depending on the particular technique used in OPCAB, there is elimination of 2 or 3 of these aortic manipulations maneuvers.

Most studies comparing CABG with and without CPB used the partial clamping of the ascending aorta to the construction of the proximal anastomoses of vein grafts, eliminating the plausible protective power of OPCAB. Additionally, current guidelines also recommend the intraoperative measure of graft flow, which can be especially useful in OPCAB in order to reduce the incidence of early grafts occlusion.

In the economic aspect, off-pump surgery has shown to reduce the cost of the procedure in our country, which constitutes an additional advantage in a country like ours, with serious constraints of health budget and with welfare hospitals tending to become budgeted. The substudy of MASS-III, comparing the costs of the two techniques showed that in OPCAB, there was decreased operating expenses and that the economy could increase the ability to care for patients by 25% [18,19].

In short, the training, the experience of the surgical team and the organizational aspect is fundamental in achieving results on the MRI, but more sharply in OPCAB technique. Specific subgroups of patients may benefit from more than one technique or the other, while a patient with chronic renal failure may benefit most from OPCAB, another diabetic patient with very ill arteries might need complete revascularization with CPB using both ITAs. Both techniques should therefore be seen as complementary and not antagonistic, with property used to provide the best outcome for our patients.

In this context, the emerging data suggests that an additional beneficial to patients can be obtained if the surgeon and staff dominate the two techniques and, therefore, must now be trained in both.

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