

Why Is “Off-Pump” Coronary Artery Bypass Grafting Better?

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ABSTRACT

The objective of this contribution is to review the results of operations we have performed upon patients using the off-pump coronary artery bypass grafting (OPCAB) technique. The OPCAB technique was examined as a cause of death in 2495 cases from September 1981 to September 1999. Our results indicated four deaths due to stroke and a total hospital mortality of 1.9% (48/2495).

When myocardial revascularization without cardiopulmonary bypass (CPB) is appropriately chosen, it is a treatment to be highly recommended for patients with coronary insufficiency.

INTRODUCTION

The location of the coronary arteries in the subepicardium allows us to perform myocardial revascularization without cardiopulmonary bypass (CPB). The performance of anastomoses on an arrested heart is comfortably familiar to the surgeon, but the more aggressive approach that accompanies extracorporeal circulation frequently imposes additional discomfort for the patient in the postoperative period. The first attempt to revascularize the myocardium without using CPB was by Kolessov in the Soviet Union [Kolessov 1967]. Kolessov's procedure involved grafting the left internal mammary artery (LIMA) to the left anterior descending coronary artery (LAD) on a beating heart through a left thoracotomy, using mechanical suture. With the advances in CPB technology, myocardial revascularization on the beating heart was abandoned in favor of coronary anastomoses, performed under the ideal conditions of a quiet field provided by CPB and cardioplegia.

Despite its technical advantages, CPB still involves a state of controlled shock. The circulation of blood outside its natural endothelium is responsible for an inflammatory reaction that leads to liberation of complement factors, cytokines, TNF- α factor [Kirklin 1983, Brasil 1998] or vasoplegic syn-

drome, which is the major complication resulting from these endocrine disturbances [Gomes 1994]. The inflammatory response leads to an increase in capillary permeability, sequestration of neutrophils, microembolism and excessive blood loss due to capillary dilatation, and plegia. The adverse reaction of endothelial disturbance is not seen clinically in the majority of cases but is always present when biochemical changes are carefully investigated in the postoperative period. The alterations in cell membranes lead to an increase of extravascular water, compromising the ideal relation between extracellular and intracellular water and resulting in the usual “wet lungs” in the immediate postoperative period [Beretti 1985]. According to the National Cardiac Surgery Database (January 1998) [Laborde 1998], brain damage during CPB may occur in 2.4% of cases during a first operation and in 3.1% during reoperations.

On the basis of these observations, surgeons attempted to revascularize the myocardium without using CPB. The first consecutive series of coronary artery bypass grafting (CABG) without extracorporeal circulation was published in by Trapp and Bisarya [Trapp 1975] and reported by Ankeney [Ankeney 1975]. These isolated experiences were soon abandoned due to technical difficulties and the currently held belief that distal perfusion of the proximal occluded coronary artery was necessary to avoid myocardial infarction even for short periods of coronary occlusion. The first instance of consecutive patients operated upon without CPB was reported by our group in 1982 [Buffolo 1982] and by Benetti in Argentina [Benetti 1985]. During the following decade, only a few centers [Buffolo 1985, Laborde 1989, Buffolo 1990, Fanning 1993, Buffolo 1996, Buffolo 1997] reported good results using this alternative for myocardial revascularization, but it led to new concerns and controversies regarding the quality of anastomoses and the benefits of the procedure [Messner 1990, Westaby 1995]. With the benefit of additional experiences, other groups began to achieve results comparable to the ones initially reported by us [Buffolo 1991, Folliguet 1997]. The advent of minithoracotomy (MIDCAB) in performing a LIMA-LAD graft on a beating heart, as originally proposed by Benetti et al. [Benetti 1985] brought attention to the possibility of performing CABG on a beating heart. Several centers that used this technique soon discovered the possibilities and advantages of a more complete revascularization using sternotomy.

In recent years, less invasive myocardial revascularization has been employed more frequently due to the introduction of stabilizers, the pressures for cost containment, and the recognition of the adverse effects of extracorporeal circulation.

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RESULTS

Intraoperative transesophageal Doppler echocardiography and transcranial Doppler studies show that cerebral embolization occurs in all patients submitted to CPB, but there is little clinical evidence of brain damage [Roach 1996, Nickhann 1997]. In our 18 years of experience, from September 1981 to September 1999, we have witnessed four deaths due to stroke and a hospital mortality of 1.9% (48/2495) in 2495 cases.

DISCUSSION

A recent survey of 162 cardiovascular surgeons showed that the term "less invasive" is defined more by the avoidance of extracorporeal circulation than by minimizing the length of skin incision [Shennib 1997]. The presence of comorbidities such as chronic renal failure, previous cerebrovascular accident, pulmonary insufficiency, advanced age, low ejection fraction, or a calcified ascending aorta strongly favors the less invasive alternative of myocardial revascularization.

In our initial experience, we employed the less invasive approach in 22% of procedures, but in recent years the percentage has increased to 36.1% in 1997, 35.6% in 1998, and 42% in 1999, despite a parallel increase in the alternative use of angioplasty and stenting.

This increase is due to the growing worldwide acceptance of these techniques as well as progress in stabilizers, development of maneuvers to expose the marginal branches ("Lima stitch"), and a different approach to revascularization that attempts to revascularize myocardial ischemic zones and not only anatomical coronary stenoses or occlusions.

A further advantage of off-pump myocardial revascularization is a reduced need for blood transfusion, with evident benefits for the patient. A retrospective analysis of our experience reveals that, in a consecutive and non-selected series of patients operated upon in the last three years, only 9% of patients revascularized on-pump did not need any blood transfusion. As for the group operated upon using the off-pump technique, the number not requiring blood transfusion was as high as 46%. Avoiding blood transfusion in myocardial revascularization offers an extraordinary advantage over the conventional technique because it reduces the possibility of transmitting known and unknown infectious diseases, avoids adverse reactions due to subgroup incompatibilities, and promotes cost containment.

Myocardial revascularization without CPB reduces costs for several reasons. In our environment, cost reductions were demonstrated in the following areas: one day less of intensive care, four days less of total postoperative hospital stay, fewer postoperative complications, and avoidance of blood transfusions and the need for oxygenators.

CONCLUSION

When myocardial revascularization without CPB is appropriately chosen, it is a treatment to be highly recommended for patients with coronary insufficiency. Unfortunately, only a subset of patients can be safely submitted to CABG on a

beating heart. Despite the advantages of this approach, it is important to select the proper patients and to avoid excessive enthusiasm in trying to use this technique in every case.

REFERENCES

1. Ankeney JL. To use or not to use pump oxygenator in coronary bypass operations. *Ann Thorac Surg* 19:108-9, 1975.
2. Benetti FJ. Direct coronary surgery with saphenous vein bypass without either cardiopulmonary bypass or cardiac arrest. *J Cardiovasc Surg* 26:217-22, 1985.
3. Benetti FJ. Video assisted coronary bypass surgery. *J Cardiac Surg* 10:620-5, 1995.
4. Borst C, Grundeman MD. Minimally invasive coronary artery bypass grafting. An experimental perspective. *Circulation* 99:1400-3, 1999.
5. Borst C, Jansen EW, Tulleken CA, et al. Coronary artery bypass grafting without cardiopulmonary bypass and without interruption of native coronary flow using a novel anastomosis site restraining device ("Octopus"). *J Am Coll Cardiol* 27:1356-64, 1996.
6. Brasil LA, Gomes WJ, Salomao R, et al. Inflammatory response after myocardial revascularization with or without cardiopulmonary bypass. *Ann Thorac Surg* 66:56-9, 1998.
7. Buffolo E. Coronary surgery without extracorporeal circulation. *Eur J Cardiothorac Surg* 5:223, 1991.
8. Buffolo E, Andrade JC, Branco JN, et al. Myocardial revascularization without extracorporeal circulation. Seven-year experience in 593 cases. *Eur J Cardiothorac Surg* 4:504-7, 1990.
9. Buffolo E, Andrade JC, Branco JN, et al. Coronary artery bypass grafting without cardiopulmonary bypass. *Ann Thorac Surg* 61:63-6, 1996.
10. Buffolo E, Andrade JC, Succi JE, et al. Direct myocardial revascularization without cardiopulmonary bypass. *Thorac Cardiovasc Surg* 33:26-9, 1985.
11. Buffolo E, Andrade JC, Succi JE, et al. Direct revascularization of the myocardium without extracorporeal circulation. Description of the technique and preliminary results. *Arq Bras Cardiol* 38:365-73, 1982.
12. Buffolo E, Gerola LR. Coronary artery bypass grafting without cardiopulmonary bypass through sternotomy and minimally invasive procedure. *Int J Cardiol* 62(Suppl)1:S89-93, 1997.
13. Fanning WJ, Kakos GS, Williams Jr, TE. Reoperative coronary artery bypass grafting without cardiopulmonary bypass. *Ann Thorac Surg* 55:486-9, 1993.
14. Folliquet TA, Laborde F, Temkine J, et al. Coronary artery revascularization without extracorporeal circulation. Indications and results. *Eur J Cardiothorac Surg* 11:870-5, 1997.
15. Gomes WJ, Carvalho AC, Palma JH, et al. Vasoplegic syndrome: a new dilemma. *J Thorac Cardiovasc Surg* 107:942-3, 1994.
16. Kirklin JK, Westaby S, Blackstone EH, et al. Complement and the damaging effects of cardiopulmonary bypass. *J Thorac Cardiovasc Surg* 86:845-57, 1983.
17. Kolesson VL. Mammary artery-coronary anastomosis as method of treatment for angina pectoris. *J Thorac Cardiovasc Surg* 54:535-44, 1967.
18. Laborde F, Abdelmequid I, Piwnica A. Aorto-coronary bypass without extracorporeal circulation: why and when. *Eur J Cardiothoracic Surg* 3:152-5, 1998.

19. Messmer BJ. Coronary surgery without extracorporeal circulation: benefit or additional risk for the patient? *Eur J Cardiothorac Surg* 5:4, 1990.
20. Nickhann GM, Goldsborough MA, Borowicz LM. Cognitive outcome after coronary artery bypass. A one-year prospective study. *Ann Thorac Surg* 63:510-5, 1997.
21. Roach GW, Kanchuger M, Mangano CM, et al. Adverse cerebral outcomes after coronary bypass surgery. Multicenter Study of Perioperative Ischemia Research Group and the Ischemia Research and Education Foundation Investigators. *N Engl J Med* 335:1857-63, 1996.
22. Shennib H, Mack MJ, Lee AGL. A survey on minimally invasive coronary artery bypass grafting. *Ann Thorac Surg* 64:110-5, 1997.
23. Trapp WG, Bisarya R. Placement of coronary bypass graft without pump oxygenator. *Ann Thorac Surg* 19:1-9, 1975.
24. Westaby S. Coronary surgery without cardiopulmonary bypass. *Brit Heart J* 73:203-5, 1995.