

Hybrid Strategies in Minimally Invasive Revascularization

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“Hybrid” or “integrated” coronary revascularization is the combination of minimally invasive coronary artery bypass grafting (CABG) to the left anterior descending coronary artery (LAD) using the left internal thoracic artery (LITA), and percutaneous coronary intervention (PCI) of the other affected vessels, with the goal of achieving a complete revascularization of patients with significant multivessel coronary artery disease (CAD) [Zenati 1999].

The rationale for hybrid revascularization is to take advantage of the best that both surgical and interventional approaches have to offer for the revascularization of the ischemic myocardium, while at the same time minimizing trauma and morbidity to the patient [Zenati 2001]. The LAD is the most important vessel of the heart, supplying circulation for up to 70% of the left ventricle, and its patency is a major determinant of survival. There is consensus among the cardiac surgery and the interventional cardiology communities that the best revascularization modality for the LAD is a surgical bypass using the LITA graft.

Initial concerns regarding the quality of the anastomosis after a MIDCAB procedure have now been eliminated in light of the results reported in a prospective randomized study (the POEM trial) designed to assess the angiographic patency, clinical outcomes, and economics of MIDCAB compared with conventional CABG. The results presented at the Scientific Sessions of the American Heart Association in November 2000 [Mehran 2001] demonstrate equivalent angiographic patency rates for the LITA-LAD anastomosis performed with the classic MIDCAB approach and for cardioplegic-arrested, on-pump CABG. On the interventional cardiology side, the success rates with balloon dilatation and stenting of the LAD have not matched the results in non-LAD targets, especially for complex lesions (Type C, AHA-ACC classification) that have shown significantly higher restenosis rates and the need for repeat revascularization in the LAD. The restenosis rates reported in the literature are as high as 59% at six months for LADs of diabetic patients requiring more than one stent. For patients with multivessel CAD including the LAD, a clear survival advantage is afforded by additional bypass grafting (besides LIMA to LAD) to the right and/or circumflex coronary artery. The most com-

monly used bypass conduit for non-LAD targets is still the saphenous vein graft (SVG), and its patency history is well known. There is an early occlusion rate of 20% to 30% in the first year, followed by a “honeymoon” period of five to six years. Late narrowing of the bypass conduit then occurs at an accelerated rate such that, at an average of 10 years after surgery, 35% to 40% of open SVGs show significant stenosis. It would appear that the long-term patency of non-LAD coronary vessels treated with interventional techniques is actually better than the patency of saphenous vein grafts.

As of April 2001, more than 20 publications were available that discuss hybrid procedures. Sixteen centers reported short- and mid-term results in 386 patients. In total, 104 of these patients were treated in the U.S. and Canada (27%), 205 patients (53%) in Europe, and 77 patients (20%) in Asia. Only one study (COMBO Trial, Francois Reeves) was a prospective analysis, while the others were retrospective [Angelini 1996, Emery 1996, Bonchek 1997, Frierich 1997, Liekweg 1997, Hattori 1998, King 1998, Mariani 1998, Cohen 1999, Dullum 1999, Fonger 1999, Lloyd 1999, Mehran 1999, Wittwer 1999, Farhat 2000, Isomura 2000, Trehan 2000, Wittwer 2000, Beholz 2001].

Recently, a meta-analysis of the results presented by five centers for hybrid procedures in 136 patients with a follow-up of greater than six months was reported by myself and colleagues [Zenati 2001]. Mean age of patients was 63 years, and 23% of patients were female. Incidence of diabetes was reported in three series, 39%, 25%, and 11.1%, respectively. Stents were used electively in 59% of the cases (range 30.7%-86%). Three centers reported on the degree of revascularization accomplished, defining complete revascularization as the revascularization of all coronary arteries with a diameter of at least 1 mm and a stenosis greater than 50% supplying a vital left ventricular wall segment. Complete revascularization was achieved in 100% of patients in two series and in 90% in the remaining series. The LITA-LAD patency determined by angiography was 100% in all series. The group at Hannover Medical School performed late angiography in 15 patients confirming 100% patency. Two groups reported on post-procedure length of hospital stay, which was 2.7 and 5 days, respectively. There was no mortality in any series. The target lesion revascularization rate (need for repeat revascularization) was 8.6% on average (range 5.5%-13.3%).

At the 2001 Trans-Catheter Therapy (TCT) Meeting, Francois Reeves, from the Hospital Notre-Dame in Montreal, presented the results of a pilot prospective case-control study known by the acronym COMBO (Combined Revascularization Of Multivessel Disease with Stenting by Radial

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Table 1. Results of COMBO pilot prospective case-control study.

	COMBO N = 35	CABG N = 35	P Value
In-hospital			
Death (%)	0	0	
Q MI (%)	1	1	
Non-Q MI (%)	2	5	
Pulmonary complications (%)	5	21	<0.0001
Number of patients transfused (n)	9	23	<0.0003
1 year follow up			
Death (%)	0	0	
All MI (%)	0	1	
New PTCA (%)	4	1	
New CABG (%)	0	0	
One-year freedom from MACE (%)	86	91	

Route and MIDCAB on LAD) [Reeves 1999]. The objectives of the COMBO study were to evaluate the feasibility and safety of a strategy of combined revascularization with stenting by radial route and MIDCAB compared to classical CABG, in order to minimize major adverse cardiac events (MACE), morbidity, repeat target vessel revascularization (TVR), and avoiding the use of saphenous vein grafts. COMBO inclusion criteria were: (1) multivessel patients initially sent for surgery; (2) all lesions (except LAD) suitable for percutaneous transluminal coronary angioplasty (PTCA); (3) chest anatomy suitable for MIDCAB (main exclusion: obesity); and (4) total revascularization achievable. The hybrid sequence began with day-one stenting, through a radial approach, of all coronary lesions (except LAD), keeping an activated clotting time (ACT) of 300 sec. and using a regimen of ASA and Plavix. On day two, a classic MIDCAB was performed. The primary endpoints were in-hospital and long-term MACE. No angiography was performed. Results are summarized in Table 1 (©).

The author of the study concluded that the COMBO procedure offers a complete revascularization for multivessel coronary disease. It diminishes noncardiac complications associated with classical CABG and is not associated with a greater number of major adverse cardiac events in the long term. The procedure also lessens the rate of repeat revascularization with multivessel PTCA. It is a promising alternative to classical CABG, especially in instances where saphenous vein grafts may be avoided.

Our group at the University of Pittsburgh performed a retrospective case control study to compare resource utilization and costs between patients undergoing hybrid revascularization and standard CABG at one month, six months, and one year after hospital follow-up. Between January 1997 and May 1999, 28 hybrid patients were compared with 41 CABG patients. The number of vessels revascularized per patient was 2.07 in the hybrid group and 2.0 in the CABG group. Hybrid patients were older (69.6 years vs. 59.4 years; $p < 0.05$), had lower left ventricular ejection fractions (LVEF)

(44.2% vs. 53.2%; $p < 0.05$), higher Parsonnet risk scores (14 vs. 6; $p < 0.05$), more chronic obstructive pulmonary disease (COPD) (46.4% vs. 7.3%; $p < 0.05$) and higher prevalence of preoperative cerebrovascular accidents (CVA) (35.7% vs. 7.3%; $p < 0.05$). The resource utilization analysis included hospital length of stay, readmission to the hospital, outpatient department visits, and cost (\$US). Length of stay (from first procedure to discharge) was significantly shorter in the hybrid group (3.2 ± 1.3 days vs. 4.5 ± 2.08 days; $p = 0.004$). The cumulative overall cost for the first postoperative year was similar in both groups ($\$23,358 \pm \$8,635$ for hybrid vs. $\$23,445 \pm \$17,287$ for CABG ($p = NS$)).

The hybrid approach provides an alternative modality of revascularization for selected patients with multivessel CAD that is safe and effective based on the published results. Nevertheless, prospective randomized studies will be necessary to determine the role of hybrid revascularization among the many available options.

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