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Multiple Arterial Off-Pump Coronary Artery Bypass Grafting: A 5-Year Experience with Clinical Results

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Bojan Biocina, MD, PhD, Zeljko Sutlic, MD, PhD, Igor Rudez, MD, MSc, Davor Baric, MD, Daniel Unic, MD, Bojan Stambuk, MD

Department of Cardiac Surgery, Dubrava University Hospital, Zagreb, Croatia

ABSTRACT

Background: The use of arterial grafts combined with the off-pump coronary artery bypass (OPCAB) procedure offers many advantages, but most of them are still to be proven in long-term studies. We present our 5-year experience in combining these 2 strategies in coronary surgery.

Methods: From February 1998 to December 2002 we operated on 155 patients (146 men and 9 women) for multiple arterial graft myocardial revascularization. All procedures were performed as OPCAB grafting using internal mammary and radial arteries. The mean ± SD was 58 ± 9 years for patient age, 57% ± 11% for left ventricle ejection fraction, and 2.3 ± 1.9 for the EuroSCORE. We reviewed perioperative and postoperative data and in-hospital mortality in our patients.

Results: A total of 356 distal anastomoses were created, an average of 2.3 per patient. The left internal mammary artery was used as a graft in 153 patients (98%), the right internal mammary artery was used in 13 patients (8%), and the radial artery was used in 146 patients (94%). No venous grafts were used. There were 4 reopenings (2.6%) because of mediastinal bleeding. Four patients (2.6%) experienced perioperative myocardial infarction, and 2 patients (1.3%) had permanent neurologic dysfunction. Five patients (3.2%) died in the hospital within 30 days of the operation.

Conclusion: Our experience shows that arterial myocardial revascularization can be safely performed as an OPCAB procedure, even in the treatment of multiple-vessel coronary disease. The long-term benefit for patients is to be evaluated in the future.

INTRODUCTION

In recent years, the procedures of arterial myocardial revascularization and off-pump coronary artery grafting have emerged and have become standard in most cardiosurgical centers. The revival of radial artery use, inspired by the efforts of Carpentier and colleagues [Carpentier 1973, Carpentier 1975], Acar and colleagues [Acar 1992, Acar 1993], and Calafiore and colleagues [Calafiore 1994a, Calafiore 1994b], has offered the possibility of achieving total arterial myocardial revascularization with excellent clinical results [da Costa 1996, Manasse 1996], promising rates of midterm patency [Possati 1998, Iaco 2001, Tatoulis 2002, Atsushi 2002], and reduced in-hospital mortality [Royse 1999].

Off-pump coronary artery bypass (OPCAB) surgery has been proven to significantly reduce the incidence of renal dysfunction [Gerritsen 2001], the length of hospital stay [Al-Ruzzeh 2002], and overall postoperative morbidity [Sabik 2002] and mortality [Cleveland 2001]. Together with the complete avoidance of aortic manipulation, OPCAB seems to decrease the incidence of postoperative neurologic dysfunction [Calafiore 2002, Kim 2002].

This case study describes our 5-year experience in combining these 2 strategies in coronary surgery and reviews perioperative and postoperative data and in-hospital mortality for 155 patients.

MATERIALS AND METHODS

From February 1998 to December 2002 there were 155 patients who underwent coronary artery bypass grafting without the use of cardiopulmonary bypass. In all cases total arterial revascularization was performed. Total arterial revascularization refers to coronary artery bypass surgery in which no venous conduit is used. Each patient received 2 or more arterial grafts. Data was prospectively collected in a database developed by the authors.

There were 146 male and 9 female patients, with a mean (± SD) age of 58 ± 9 years and a range of 30 to 76 years. Fifty-six patients (36%) had survived previous myocardial infarction, 33 (21%) had diabetes mellitus, and 27 (17%) exhibited stenosis of the left main coronary artery. The mean left ventricle ejection fraction was 57% ± 11%, and the mean EuroSCORE (European System for Cardiac Operative Risk Evaluation) of the group was 2.3 ± 1.9 (range, 0-9). Six patients (4%) had undergone previous cardiac surgical procedures. Preoperative data are presented in Table 1.

Surgical Procedure

The OPCAB grafting was performed via a full median sternotomy. Arterial conduits were harvested and used according to the clinical judgment of 3 surgeons. The radial artery from the nondominant or both hands, if intended for grafting use, was harvested with standardized techniques [Dietl 1995, Baric 2000]. In 7 patients (5%), endoscopic harvesting of the radial artery was performed [Connolly 2002]. The left or both

Address correspondence and reprint requests to: Bojan Biocina, MD, PhD, Dubrava University Hospital, Av. Gojka Suska 6, 10000 Zagreb, Croatia; 385-1-290-2515; fax: 385-1-290-3819 (e-mail: bojan.biocina@zg.tel.hr).

Table 1. Patient Demographics (n = 155)*

Age (range), y	58 ± 9 (30-76)
LVEF (range), %	57 ± 11 (25-71)
EuroSCORE (range)	2.3 ± 1.9 (0-9)
Arterial hypertension, n	77 (50%)
Diabetes mellitus, n	33 (21%)
Hyperlipidemia, n	89 (57%)
Unstable angina, n	26 (17%)
Myocardial infarction, n	56 (36%)
LVEF <35%, n	13 (8%)
Left main stenosis, n	27 (17%)
Redo procedure, n	6 (4%)

*Data are expressed as the mean ± SD where appropriate. LVEF indicates left ventricular ejection fraction; EuroSCORE, European System for Cardiac Operative Risk Evaluation.

internal mammary arteries were harvested and used as semi-skeletonized grafts. Intraoperative vasoplegia of arterial grafts was achieved with a modified vasoplegic solution [He 1996]. Partial heparinization with 100 IU/kg and an activated coagulation time maintained above 200 seconds was initiated during arterial graft harvesting and was not converted with protamine sulfate at the end of the procedure. Sites of distal anastomoses were stabilized with the Medtronic Octopus 2 or 3 devices (Medtronic, Minneapolis, MN, USA). The Starfish Medtronic Heart Positioner (Medtronic) was used for facilitating exposure of inferior and posterior wall coronary arteries. Intracoronary shunts (Clear view; Medtronic) were regularly used to enable distal perfusion, reduce the intraoperative bleeding, and improve the safety of the operation. A blower using humidified CO_2 was employed as well.

The first target vessel was always the left anterior descending artery, followed by the vessels in the circumflex artery territory and, finally, the right coronary artery territory. In 34 patients at higher risk for neurologic complications (eg, carotid artery stenosis, severely calcified ascending aorta), an aortic "no-touch" technique was used. Instead of being made at the site at the ascending aorta, a proximal anastomosis was created in Y fashion between the radial artery and the left or right internal mammary artery. Intraoperative transesophageal echocardiography for the detection of possible global or regional wall-motion abnormalities was used with all patients. Aspirin 100 mg per day was routinely used as an antithrombotic agent, and amlodipine was used for late spasm prevention.

RESULTS

A total of 365 distal anastomoses were created, an average of 2.30 per patient (range, 2-4). The left internal mammary artery was used in 140 patients (90%). Both left and right internal mammary arteries were used in 13 patients. Radial arteries were used in 146 patients (94%), one in 118 patients (76%) and both in 28 patients (18%) (Table 2). Forty-nine percent of all distal anastomoses were placed in left anterior descending artery territory, 27% were placed in the circumflex artery, and 24% were placed in right coronary artery territory (Figure 1). Four patients had reopenings (2.6%)

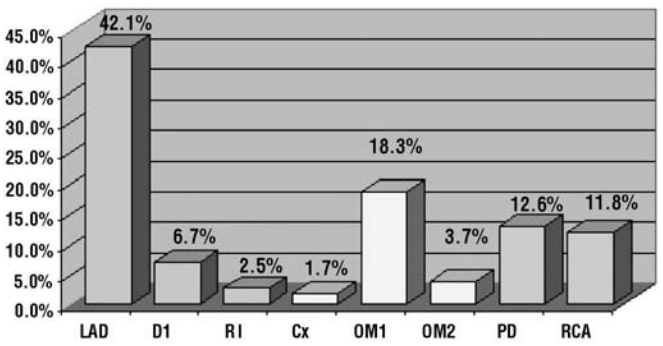
Table 2. Used Arterial Conduits (n = 155)

Internal mammary artery, n	153 (99%)
Left	140 (90%)
Left and right	13 (8%)
Radial artery, n	146 (94%)
Left	117 (75%)
Right	1 (1%)
Both	28 (18%)

because of mediastinal bleeding, 4 patients (2.6%) experienced perioperative myocardial infarction, and 2 patients (1.3%) experienced permanent neurodysfunction after cerebrovascular incidents. New postoperative atrial fibrillation events occurred in 16 patients (10%). There were 5 in-hospital deaths (3.2%). One patient died of hemorrhagic shock due to a ruptured aorta, 1 died of mediastinitis, 1 died of mesenteric ischemia, 1 died after experiencing a massive postoperative myocardial infarction, and 1 patient with marginally significant bilateral carotid artery stenoses died after experiencing a fatal postoperative stroke. There were no local complications related to radial artery harvest.

DISCUSSION

After obtaining unsatisfactory long-term patency results with venous grafts, compared with results obtained with the internal mammary artery, we reconsidered total arterial revascularization as a possibility for avoiding all the complications of venous graft failure. The first experiences with using the radial artery as a graft in coronary revascularization [Carpentier 1975] failed because of the unavailability of antispasmodic agents and the use of a harvesting technique that did not take into consideration the need to preserve endothelial function. Those challenges were subsequently met, and radial artery use was revived in the early 1990s [Acar 1992]. The radial artery has since been considered as equally valid a choice for bypass grafting as the saphenous vein. Excellent clinical results and midterm patency rates justify its extensive use in coronary surgery. In Dubrava University Hospital, we



Anastomosed vessel distribution. LAD indicates left anterior descending artery; D1, first diagonal branch; RI, ramus intermedius; Cx, circumflex artery; OM1, obtuse marginal artery 1; OM2, obtuse marginal artery 2; PD, posterior descending artery; RCA, right coronary artery.

started a program of total arterial revascularization in February 1998 and have performed the operation in more than 350 patients since then. During this period, the radial artery became the conduit of first choice (besides the still undisputed internal mammary artery) for coronary artery surgery. Furthermore, in 2002 we mastered endoscopic radial artery harvesting with excellent clinical and cosmetic results, which therefore have persuaded the female patient population to accept radial artery harvesting. At the same time, our experience with OPCAB procedures and the improvements in stabilization devices have allowed us to perform multiple artery grafting in almost every patient with coronary artery disease.

The rates of neurologic complications following off-pump coronary revascularization that have been described in literature are approximately 1% [Calafiore 2002]. Reports that have shown how important it is to avoid any manipulation of the ascending aorta in patients with extracoronary vasculopathy have stimulated us to perform the aortic no-touch technique in selected patients and have enabled us to achieve similarly low rates of neurologic complications. Our experience in combining the concepts of arterial revascularization and off-pump coronary surgery has produced satisfactory results during this 5-year period with an in-hospital death rate similar to those described in previously published studies. None of the deaths seem to be related to any graft problem. Both mortality and morbidity rates in our group of patients correspond to those of other published results and seem acceptable.

CONCLUSION

The OPCAB technique has already been shown to permit total myocardial revascularization in most patients who require coronary surgery. The method is safe and reproducible and has an even greater benefit for high-risk patients. The extensive use of arterial grafts, furthermore, offers the promise of long-term patency. Our experience shows that arterial myocardial revascularization can be safely performed as an OPCAB procedure, even in cases of multiple-vessel coronary disease.

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