

A Review of 140 Octopus Off-Pump Bypass Patients Over the Age of Seventy: Procedure of Choice?

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ABSTRACT

Background: Many studies have demonstrated that patients of advanced age are at increased risk for morbidity and mortality following coronary artery bypass graft (CABG) surgery. When compared to younger age groups, the risks of adverse neurological outcome or mortality have been demonstrated to be higher in septuagenarians and octogenarians. It has been suggested that off-pump coronary artery bypass (OPCAB) surgery, by avoiding the adverse effects of cardiopulmonary bypass (CPB), may improve the risks of morbidity and mortality, particularly in these higher risk elderly patients. Despite the increased rates of adverse events in patients of advanced age, various authors have described these risks to be in the acceptable range, justifying continued recommendations for operative revascularization in properly selected elderly patients. OPCAB theoretically may provide improvements in early outcomes for these patients by avoiding the unwanted sequelae of CPB.

Patients and Methods: This report is a study of the potential advantages of OPCAB techniques based on a retrospective analysis of 140 patients aged 70 or more operated on by a single surgeon at a single institution using OPCAB techniques during a 39-month period. In these operations, surgical access was almost exclusively via mid-line sternotomy. Exposure of target coronary arteries was by means of extended inverted-T pericardiotomy. Local occlusion of coronary arteries was achieved using proximally placed silastic tapes (Quest Medical Inc., Allen, TX). Distal occlusion was rarely needed. Stabilization was obtained exclusively with the suction-based Octopus' stabi-

lization system (Medtronic, Inc., Minneapolis, MN). A mean number of 2.36 +/- 0.95 distal anastomoses were constructed per patient, with a range from one to five. Multivessel OPCAB patients averaged 2.73 grafts per patient.

Results: Of the 142 patients who underwent OPCAB surgery, only two required elective conversion to CABG with CPB. The procedure was safe, with no need for urgent conversion to CPB. Myocardial protection was excellent, with no patient requiring inotropic support leaving the operating room, and no patient developed postoperative stroke. Several patients had evidence of temporary nocturnal confusion but recovered prior to discharge. There were no in-hospital or 30-day post-operative mortalities in this group.

Conclusions: OPCAB has been demonstrated to be safe and effective, with surgeons from many centers worldwide reporting low rates of morbidity and mortality. Early patency rates appear to be equal to or perhaps even better than CABG with CPB. This report adds to a growing body of literature supporting the use of OPCAB in elderly patients requiring surgical revascularization. If further investigations continue to demonstrate improved outcomes, OPCAB may become the procedure of choice for patients of advanced age.

INTRODUCTION

The elderly represent a rapidly increasing proportion of the population in the United States and many other nations, and heart disease is the leading cause of morbidity and mortality in older people. Interventional cardiologists are treating an increasing proportion of coronary heart disease patients early in the natural progression of their disease. These factors have resulted in progressively more elderly patients presenting to cardiac surgeons in need of surgical myocardial revascularization. Many studies have demonstrated that patients of advanced age are

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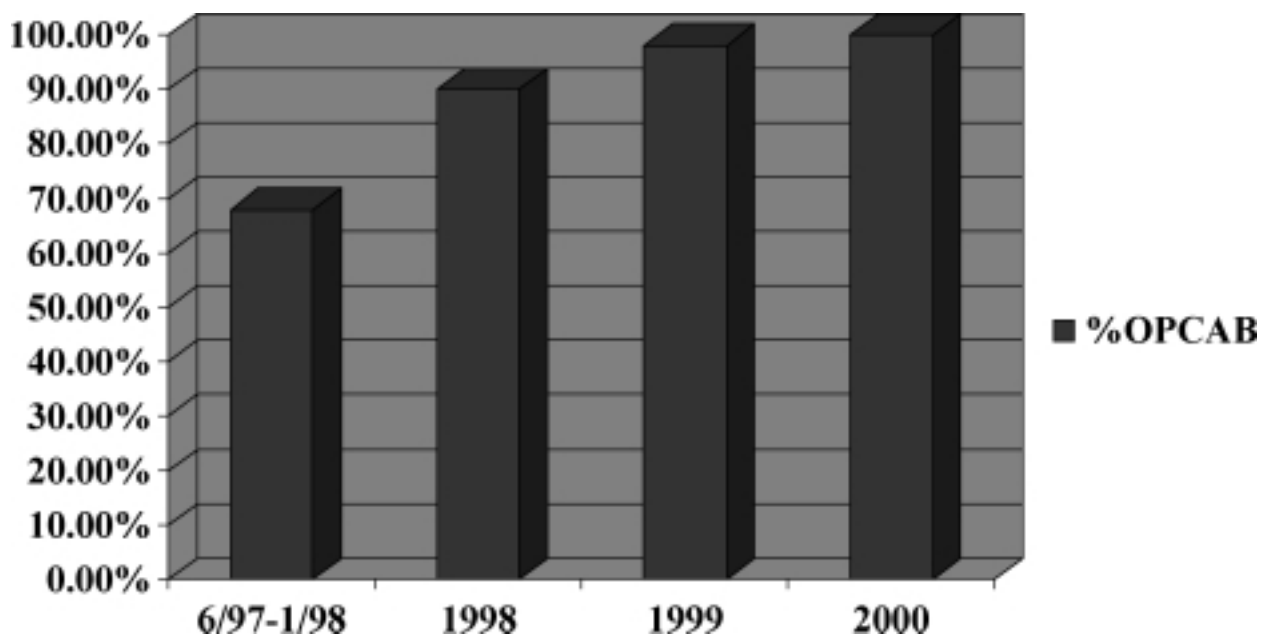


Figure 1. During the study period, increasing proportions of elderly CABG patients had their procedures completed with OPCAB techniques.

at increased risk for morbidity and mortality following coronary artery bypass graft (CABG) surgery [Peigh 1994, Tsai 1994, Cane 1995, Katz 1995, Morris 1996, Akins 1997, Ivanov 1998, Kirsch 1998, Craver 1999, Fruitman 1999, Alexander 2000, Hirose 2000]. When compared to younger patients, the risks of adverse neurological outcome or mortality have been demonstrated to be higher in septuagenarians and octogenarians. Longer postoperative length of hospital stay, increased time in intensive care units, and more need for prolonged post-discharge skilled care result in significantly more expensive episodes of care [Tuman 1992, Roach 1996, van Dijk 2000]. Previous reports have concluded however, that although morbidity and mortality following CABG in the elderly are higher, outcomes of CABG have been satisfactory and support continued use of surgical revascularization in properly selected patients.

Recent interest in off-pump coronary artery bypass (OPCAB) surgery, in part, reflects surgeons' recognition that a kinder and gentler procedure may be needed to address the difficulties encountered in CABG surgery in the elderly. By avoiding the adverse effects of cardiopulmonary bypass (CPB) it has been suggested that morbidity and mortality may be improved, particularly in these higher risk patients [Boyd 1999, Diegeler 2000, Koutlas 2000, Ricci 2000, Stamou 2000, Yim 2000].

Although neurological injury following conventional CABG may be due to many causes and is correspondingly difficult to study [Murkin 1995, Borowicz 1996, Gill 1996, Mahanna 1996, Blackstone 2000], OPCAB theoretically could reduce embolic brain injury through the avoidance of aortic manipulation required for cannulation, cross-clamping, and flow disturbance from perfusion jets. The

elderly may particularly benefit from OPCAB considering their higher incidence of aortic atheromatous disease.

This report is a study of the potential advantages of OPCAB techniques based on a retrospective analysis of all patients aged 70 or more operated on by a single surgeon at a single institution using OPCAB techniques during a 39-month period. Patient selection, operative details, and early outcomes were analyzed.

PATIENTS

From June 10, 1997 through September 10, 2000, 155 patients aged 70 or over underwent CABG performed by the author at a single institution. During this time OPCAB was used in increasing proportions of patients as techniques were developed allowing access to more coronary artery targets (Figure 1, ●). Of these 155 elderly patients, 142 had attempted OPCAB. Two patients required non-urgent conversion to CPB-supported CABG early in the experience and recovered uneventfully, but were excluded from this series. The remaining 140 patients form the basis for this report. Data were entered prospectively into a locally maintained database and were retrieved retrospectively for analysis.

The 140 patients had a mean age of 75.4 \pm 4.5 years, with a range from 70 to 89. Twenty-seven (19.3%) were octogenarians. Males comprised 63.65% of the group and 10 (7.1%) were having second, third, or fourth CABG procedures. One hundred thirty-two (94.3%) were in NYHA functional class III–IV and fourteen (10%) needed urgent or emergent CABG. Mean left ventricular ejection fraction (LVEF) was 50.1% (range 20%–75%). Other demographics are listed in Table 1 (●).

Table 1. Preoperative Demographics

MI	DM	HTN	SMOKER	COPD
47.9%	22.9%	65.0%	55.7%	15.7%
RENAL	CEREBR	PVD	L MAIN	IABP
5.0%	12.9%	22.1%	27.1%	3.6%

MI = Preoperative myocardial infarction, DM = Diabetes mellitus, HTN = Hypertension; SMOKER = Preoperative smoking history, COPD = Chronic obstructive pulmonary disease, RENAL = Preoperative renal insufficiency, L MAIN = Left main coronary artery disease, IABP = Preoperative intra-aortic balloon pump

METHODS

Access was almost exclusively via midline sternotomy. After harvesting of conduits, anticoagulation was achieved with heparin (1.5-2.0 mg/kg). Target activated clotting time (ACT) was 275-300 seconds. Heparin was administered every 30-40 minutes as needed to maintain the ACT. Exposure of target coronary arteries was via extended inverted-T pericardiotomy, including a vertical posterior pericardiotomy on the right, excising the pericardium off the diaphragm posteriorly toward the inferior vena cava. This incision when combined with opening of the right pleural space allowed unobstructed access to enable displacement of the cardiac apex into the right chest with minimal hemodynamic disturbance (Figures 2, 3, and 4). Every effort was made to preserve normal

cardiac output and blood pressure during displacement to minimize the risk of end-organ ischemia. Pharmacological support was avoided when possible. Local occlusion of coronary arteries was achieved using proximally placed silastic tapes (Quest Medical Inc., Allen, TX). Distal occlusion was rarely needed. Bleeding from the arteriotomy was cleared using a mist of warm ph-balanced fluid with low CO₂ gas flow rates (1.5-3.0 liters/minute), avoiding intimal trauma. Tolerance to regional ischemia was routinely assessed with a five-minute test occlusion of the target artery followed by a two-minute reperfusion period. Stabilization was obtained exclusively with the suction-based Octopus' stabilization system (Medtronic, Inc., Minneapolis, MN), avoiding cardiac compression and its untoward hemodynamic consequences. Indwelling coronary shunts were rarely used. With proper cardiac displacement techniques and preservation of normal hemodynamics, regional ischemia was almost always well tolerated with little or no further deterioration in cardiac function. Heparin was fully reversed at the completion of the procedure and patients were maintained on aspirin postoperatively.

A mean number of 2.36 +/- 0.95 distal anastomoses were constructed per patient, with a range from one to five (Figure 4, 5). Multivessel OPCAB patients averaged 2.73 grafts per patient. A total of 327 grafts were constructed, 163 to the left anterior descending system, 87 to the circumflex system, and 77 to the right coronary artery territory. Internal thoracic artery grafts were used in 97.9% of patients and 60.2% of all grafts were arterial.

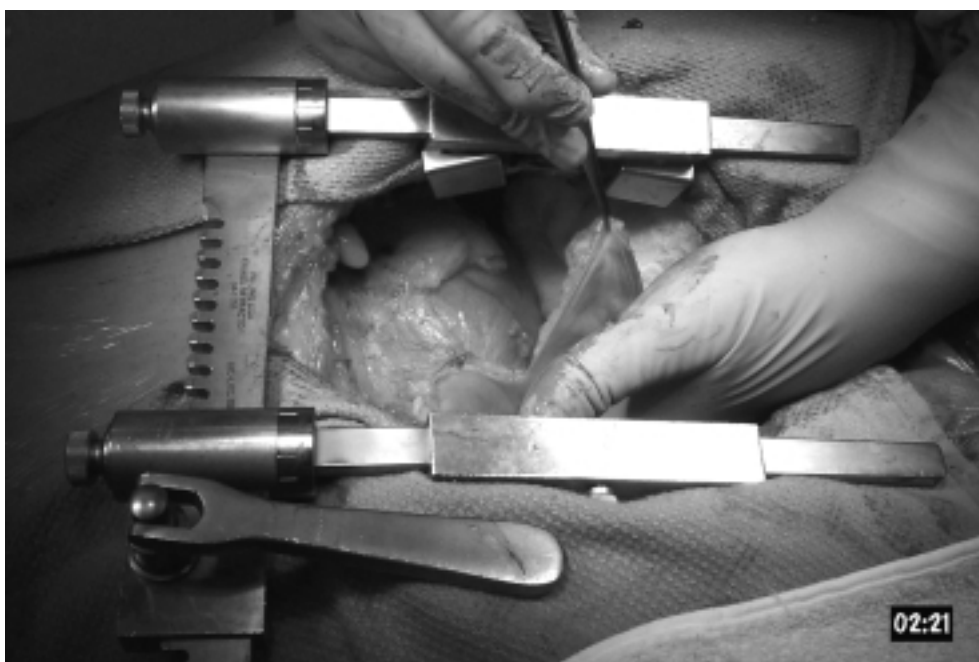


Figure 2. View from the patient's left side demonstrating the vertical posterior pericardiotomy that provides space for cardiac displacement for lateral wall coronary exposure without cardiac compression.

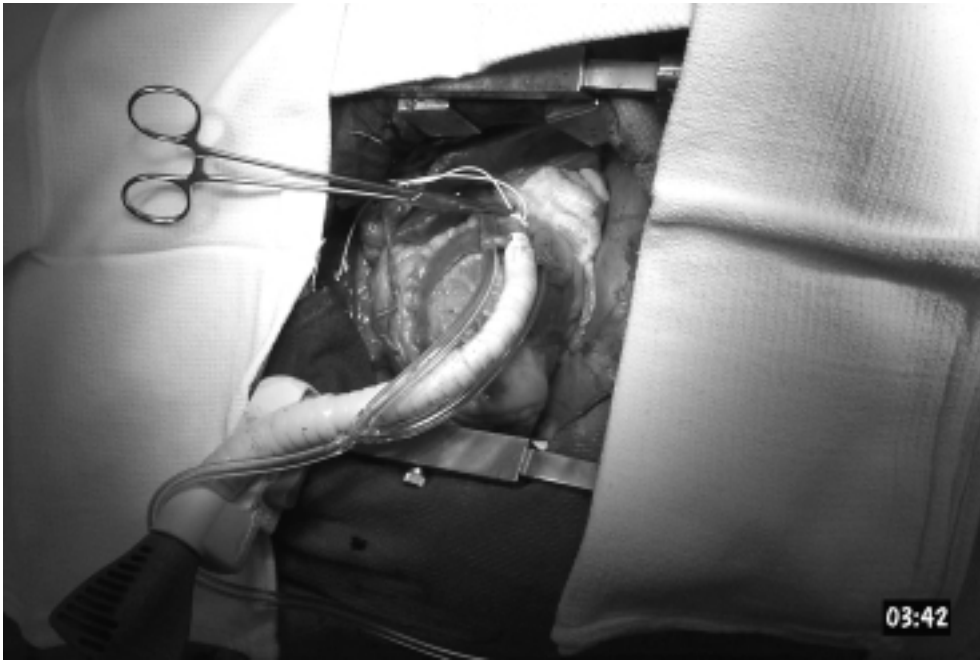


Figure 3. The heart is rotated into the right chest with the apex resting on the right hemidiaphragm and is able to provide near normal hemodynamics without large increases in preload or pharmacological intervention.

RESULTS

One hundred forty-two patients underwent OPCAB surgery and only two required elective conversion to CABG with CPB. These conversions occurred early in the series because reliable access to the lateral wall was difficult prior to development of surgical exposure techniques. No urgent

conversions to CPB were necessary and no patient required conversion during the last 33 months. Operative and early postoperative complications are shown in Tables 2 (⊙) and 3 (⊙). There were no in-hospital or 30-day operative mortalities. Predicted mortality was 3.57% +/- 4.78% ($p < 0.05$) (STS National Cardiac Surgical Database Predicted Mortality). Postoperative length of stay averaged 5.9 +/- 3.3 days.

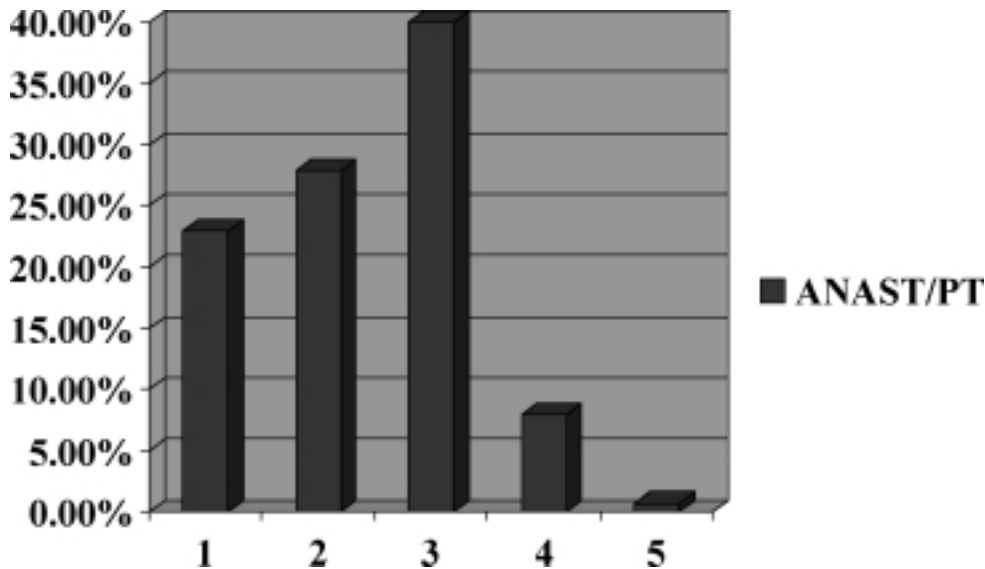


Figure 4. Distribution of the number of distal anastomoses per patient.

Table 2. Operative Complications

CONV	URG CONV	INOT	IABP	BLEED	TX
1.4%	0.0%	0.0%	0.0%	0.0%	42.9%

CONV = Conversion to CPB, URG CONV = Urgent conversion to CPB, INOT = Need for inotropic support leaving the operating room, IABP = Need for new intra-aortic balloon pump, TX = Need for transfusion of any blood products perioperatively

DISCUSSION

Operative morbidity and mortality following CABG with CPB in the elderly are known to be HIGHER than in younger cohorts. However, various authors have described these increased rates of adverse events to be in the acceptable range, justifying continued recommendations for operative revascularization in properly selected elderly patients. OPCAB theoretically may provide improvements in early outcomes for these patients by avoiding the unwanted sequelae of CPB.

This series of 140 elderly patients with significant comorbidity underwent successful OPCAB with very low rates of morbidity. The procedure was safe, with no need for urgent conversion to CPB. Myocardial protection was excellent, with no patient requiring inotropic support leaving the operating room, and no patient needed a new intra-aortic balloon pump (IABP), even patients with severely impaired left ventricular function. Furthermore, no patients were returned to the operating room for bleeding. The need for perioperative transfusion in 42.9% of patients was higher than in the author's overall OPCAB experience (432 cases, 33.1% receiving transfusion) and likely reflects a lower transfusion threshold in the elderly. The single patient who required postoperative dialysis had developed heparin-induced thrombosis with hepato-renal failure and required digital amputations. Acute tubular necrosis developed in this patient despite normal hemodynamic performance and required hemodialysis for one week, following which renal and hepatic function returned to baseline levels.

Importantly, no patient developed postoperative stroke. Several patients had evidence of temporary nocturnal confusion but recovered prior to discharge. There were no in-hospital or 30-day post-operative mortalities in this group.

This report adds to a growing body of literature supporting the use of OPCAB in elderly patients requiring surgical revascularization. If further investigations continue to demonstrate improved outcomes, OPCAB may become the procedure of choice for patients of advanced age.

LIMITATIONS

This report is limited in that it is an observational retrospective analysis. No control group of CPB CABG patients was used for direct comparison. Although the large majority of elderly patients operated on by the author during the

Table 3. Postoperative Complications

MI	STROKE	CONFUSION	AFIB	RENAL
0.7%	0.0%	4.2%	17.1%	0.7%

MI= Perioperative myocardial infarction, STROKE = Perioperative stroke, CONFUSION = Postoperative confusion, AFIB = Postoperative new atrial fibrillation requiring treatment, RENAL = New postoperative renal failure requiring dialysis

study period received OP-CAB, there was some selection bias. Early in the series, patients with circumflex coronary artery disease were more likely to have CABG with CPB because access to the lateral wall was more difficult prior to the development of surgical exposure techniques. One patient later in the series had CPB CABG following catheterization which demonstrated severe left main coronary artery disease. The patient had ongoing ischemic symptoms and modest hemodynamic instability despite preoperative institution of intra-aortic balloon pumping. He survived emergency CPB CABG and recovered uneventfully.

CONCLUSIONS

OPCAB has been demonstrated to be safe and effective, with surgeons from many centers worldwide reporting low rates of morbidity and mortality [Spooner 1999, Hart 2000]. Early patency rates appear to be equal to or perhaps even better than CPB CABG (Puskas, Society of Thoracic Surgeons, Fort Lauderdale, FL, USA, January 2000). It will be important for future investigations to demonstrate which subgroups of patients gain the most benefit from OPCAB. Longitudinal studies will be important to evaluate the rate of return of symptoms, the need for re-intervention, and survival curves.

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