MANAGAMENT OF CONVERSIONS TO CARDIOPULMONARY BYPASS IN BEATING HEART CORONARY SURGERY

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Abstract

This study investigated outcomes in patients undergoing coronary artery bypass grafting (CABG) without cardiopulmonary bypass (CPB), who needed conversion to CPB. Between September, 1998 and September, 2003, 1000 CABG procedures were performed in a Cardiovascular Clinic, University Clinical Centre Tuzla. Multivessel CABG were selected arbitrarily for CABG without CPB (OPCAB) or CABG with CPB (ONCAB). Patients who required conversion due to technical difficulty with grafting were performed with ONCAB including cardioplegic arrest. Patients with severe hemodynamic instability and cardiac arrest were performed as ONCAB without crossclamping, while patients converted for mild to moderate hemodynamic instability were given cardioplegic arrest or not, depending on surgeon preference. 493 operations were scheduled and performed as ONCAB (49,3%), 468 as OPCAB (46,8%) and 39 originally scheduled OPCAB operations were converted to ONCAB (7,7% of originally scheduled OPCAB patients or 3,9% of total number of CABG). Reasons for conversions were: mild to severe hemodynamic instability - 28 (71,8%); poor vessels or difficult graft revision - 11 (28,2%). Patients converted because of technical difficulty or mild hemodynamic instability behaved as regular ONCAB patients. In the 9 patients who were emergently converted due to cardiac arrest or ventricular fibrillation, 3 patients had stroke and 3 severe myocardial ischemia requiring intraaortic balloon pump. It is of great importance to keep conversions to CPB due to cardiac arrest at a low level. The serious complications seen in such patients can significantly impede the overall benefits of a successful OPCAB program.

KEY WORDS: conversions, cardiopulmonary bypass, beating heart

Introduction

Coronary artery bypass grafting (CABG) without cardiopulmonary bypass (CPB)- beating heart or OPCAB, has been the preferred approach to treat coronary artery disease in our center. The purpose of this study was to study outcomes in the group of OPCAB patient that during the procedure were converted to CPB.

Patients and Methods

1000 CABG procedures performed between September, 1998 and September, 2003 in a Cardiovascular Clinic, University Clinical Centre Tuzla were reviewed. CABG with CPB (ONCAB) was carried out through median sternotomy. Myocardial protection was achieved by intermittent anterograde and/ or retrograde cold blood cardioplegia. After completion of distal anastomoses on the arrested heart, the aortic cross-clamp was removed and the proximal anastomoses performed with partial occlusion of the aorta. OPCAB was mainly done through median sternotomy (32 performed as minimally invasive direct coronary artery bypass -MIDCAB). To achieve adequate exposure of the heart a deep pericardial LIMA stitch (1) was placed in the oblique sinus of the posterior pericardium. By manipulating this stitch positioning of the heart was safe and effective (2).

The target vessel was exposed and snared above and/ or below the anastomotic site using a 4-0 pledgetted Prolene suture and soft rubber tourniquet to avoid injury to the coronary artery. An intra coronary shunt was frequently used to prevent bleeding during the anastomosis and distal ischaemia (3). Visualization of the anastomotic site was improved by a surgical blower. The CPB machine was kept in the immediate vicinity with the circuit mounted but without priming. Left anterior descending artery was revascularized first prior to major manipulation of the heart. Heparin was given in doses of 3 mg/kg in ONCAB to keep the ACT above 400 sec, and in OPCAB 2 mg/kg to keep ACT above 300 sec.

Intraoperative flow verification with Transit Time Flow Measurement (TTFM) was used in all grafts as a quality assurance measure (4). When no reversible cause of poor TTFM results were identified the graft was revised (5). In ONCAB all grafts were checked while the patient was still on CPB and after weaning from CPB prior to decannulation. In case of malfunctioning grafts the patient was placed back on CPB and the grafts revised with or without new cardioplegic arrest. In OPCAB, TTFM was performed after the completion of each graft. Grafts were revised if necessary before embarking on additional grafts (6). In OPCAB procedures TTFM measurements were in general performed with and without proximal obstructive snare on the native vessel to test for distal patency, this in general was not used for ONCAB operations (7).

As conversions were counted all patients who were scheduled and started as OPCAB and were placed on CPB during the course of the procedure. After the decision had been made to convert, the pump was rapidly primed, the patients fully heparinised and rapid cannulation performed after placing purse string sutures on the aorta and right atrium. In case of ventricular fibrillation (VF) or cardiac arrest patient was immediately defibrillated and cardiac massage initiated if necessary. The operation was then completed with or without cross clamping of the aorta and cardioplegic arrest depending on the situation. In some cases the decision to convert was made immediately after opening the pericardium when vessels were found to be intramuscularly located, in patients with very severe and diffuse coronary disease and in some cases where the anastomosis was not functioning well by TTFM. In these patients regular ONCAB was performed with cardioplegic arrest. If there was mild hemodynamic instability during the early part of the procedure or during positioning of the heart, the surgeon would perform ONCAB with or without cardioplegic arrest. In cases with evidence of severe hemodynamic instability, VF and cardiac arrest the patient would be cannulated and the procedure performed on the beating, perfused heart without crossclamping and cardiac arrest. This was done to minimize global ischemia on an already regionally ischemic heart. OPCAB patients who needed graft revisions usually had their graft(s) revised without CPB.

Results

A total of 493 operations were scheduled and performed as ONCAB (49,3%), 468 as OPCAB (46,8%) and 39 originally scheduled OPCAB operations were converted to ONCAB- this constituted 7,7% of originally scheduled OPCAB patients or 3,9% of total number of CABG. 11 patients (28,2%) were converted due to technical factors including difficult graft revisions. 19 patients (48,7%) were converted due to mild to moderate hemodynamic instability while 9 patients (23,1%) were converted due to cardiac arrest and severe hemodynamic instability (Table 1).

Reasons for conversion		N	%
Technical factors			
	Intramuscular vessels	1	2,5
	Poor native vessels	2	5,1
	Graft revision	8	20,5
	Total	**11**	**28,2**
Hemodynamic instability			
	Mild to moderate	19	48,7
	Severe	9	23,1
	Total	**28**	**71,8**

TABLE 1. Reasons for conversion

Patients who were converted due to technical reasons did well and similar to patients who underwent regular ONCAB. Only one patient (9,1%) had ischemic complications in the form of stroke. This patient had diabetes and previous TIAs.

He recovered well postoperatively. 9 patients who were converted due to cardiac arrest or very severe hemodynamic disturbance survived, but 6 (66,6%) of them had severe ischemic complication (Table 2).

Reasons for conversion		*Stroke*	*IABP*	*Total*
Technical factors	(n=11)	1 (9,1%)	0 (0,0%)	1 (9,1%)
Hemodynamic instability				
Mild to moderate	(n=19)	0 (0,0%)	0 (0,0%)	0 (0,0%)
Severe	(n= 9)	3 (33,3%)	3 (33,3%)	6 (66,6%)

TABLE 2. Ishemic complications in converted patients

IABP-intraortic balloon pump

All CABG patients were retrospectively reviewed to identify risk factors for conversion to CPB. Demographic data of patients in all three groups are shown in Table 3. All groups were comparable in terms of gender, age and ejection fraction. Groups were predominantly male, average age was similar and ejection fraction almost identical. The number of grafts per patient was higher in the ONCAB group (3,1) than in the OPCAB group (2,0). This was probably due to a tendency to select patients with more grafts for ONCAB and not to graft very small vessels with OPCAB technique. There was therefore no particular risk factor that could be identified as a risk for conversion.

	ONCAB	OPCAB	CONV
Number	493	468	39
Mean age	56,2	57,1	57,4
Mean EF	51,9 %	52,4%	51,4%
Grafts per patient	3,1	2,0	2,8

TABLE 3. Reasons for conversion

CONV-conversions to cardiopulmonary bypass, EF-ejection fraction

Major ischemic postoperative complications are shown in Table 4. The most common ischemic complication was stroke and global myocardial ischemia requiring intraaortic balloon pump (IABP). There were no deaths in the converted patients (0,00%) while in the ONCAB group 11 deaths (2,2%) and in OPCAB group 2 (0,4%) were registered (Table 4).

	ONCPB	OPCPB	CONV
Stroke	9 (1,8%)	5 (1,1%)	4 (10,3%)
IABP	4 (0,8%)	1 (0,2%)	3 (7,7%)
Total ishemic comp.	13 (2,6%)	6 (1,3%)	7 (17,9%)
Mortality	11 (2,2%)	2 (0,4%)	0 (0,00%)

TABLE 4. Postoperative morbidity and mortality

DISCUSSION

OPCAB has been used as the primary mode of treatment for patients with multivessel coronary artery disease in our center. Patients with single vessel disease are treated with percutanous intervention and in some cases MIDCAB procedures. This is due to the belief that complication rate is reduced by using OPCAB (8). Additionally the economical condition in our country makes it necessary to reduce cost as much as possible and OPCAB in our setting significantly reduces the surgical cost.

Conversion to CPB is a relatively common occurrence in OPCAB surgery (9). The OPCAB procedure requires excellent cooperation between surgeon and anaestesiologist. Conversion usually occurs because of technical difficulty related to the grafting or to hemodynamic instability. Conversion due to technical factors and without significant hemodynamic instability does not cause serious problems. This is what we found in our study and is not surprising since the patients converted did not have particular risk factors for CPB. The one patient in this group that had a stroke did have previous TIA before the operation.

Hemodynamic instability usually occur due to ischemia or excessive changes in pre or afterload during positioning. When the changes in hemodynamics were mild and the patient rapidly converted to CPB we did not see any adverse effects regardless of management. Patients that were operated with cardioplegic arrest or

on a CPB supported beating heart all did well. The 9 patients that suffered severe hemodynamic collapse and required defibrillation and cardiac massage did not do well. 6 of these patients had stroke or evidence of severe myocardial ischemia. We believe that these patients represent a deficiency in the detection or management of myocardial ischemia. The main tools for detection of ischaemia in our practice is monitoring of ECG and hemodynamic status. We do not routinely use pulmonary artery catheter or transesophageal catheter and in the majority of these 9 cases no warning was seen before the dramatic events necessitating conversion.

Conclusion

It is of great importance to keep conversions to CPB due to cardiac arrest at a low level. The serious complications seen in such patients can significantly impede the overall benefits of a successful OPCAB program.

List of Abbrevations

CABG	-	coronary artery bypass grafting
CPB	-	cardiopulmonary bypass
OPCAB	-	coronary artery bypass grafting without cardiopulmonary bypass
ONCAB	-	coronary artery bypass grafting with cardiopulmonary bypass
CONV	-	conversions to cardiopulmonary bypass
MIDCAB	-	minimally invasive direct coronary artery bypass
TTFM	-	Transit Time Flow Measurement
VF	-	ventricular fibrilation
IABP	-	intraortic balloon pump

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