CONVERSIONS IN OFF-PUMP CORONARY ARTERY BYPASS GRAFTING: ANALYSIS AND OUTCOME

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Abstract

Background: Off-pump coronary artery bypass graft (CABG) surgery is supposed to reduce perioperative mortality and morbidity compared with on-pump coronary bypass graft surgery. The causes of hemodynamic collapse during off-pump coronary artery bypass (OPCAB) remain scarcely defined. We present an analysis of 7 cases who were converted to conventional CABG due to sustained hemodynamic collapse or else, during elective off- pump CABG.

Method: During a 12-month period, we performed 77 elective OPCAB procedures through a sternotomy, constituting 56.2% of the total CABG procedures performed. Six patients (1.6%) experienced hemodynamic collapse intra-operatively and one (0.23%) electively requiring immediate cardiopulmonary bypass. Preoperative characteristics, intraoperative data, and postoperative outcome were retrospectively reviewed.

Results: In all cases, improvements in intra-operative technique and/or judgment could be made retrospectively. Six of these patients were converted in emergency, and one electively to cardiopulmonary bypass. Three (3/77) patients had an unstable course and did not survive operation.

Conclusions: The causes of hemodynamic collapse during elective OPCAB were ischemic, mechanical, or a combination of both. Based on these results, strong consideration should be given for a planned strategy of CPB in high risk patients.

Key Words: CABG; emergency; conversion; off-pump; on-pump.

INTRODUCTION

Off-pump coronary artery bypass grafting (OPCAB) has been shown to be a safe procedure with similar or better outcome to conventional coronary artery bypass grafting (CABG). However, emergency conversion to cardiopulmonary bypass (CPB) is occasionally required due to hemodynamic compromise[1,2], bleeding and arrhythmias. It has been recognized to increase operative mortality and morbidity[3-6]. Identifying predictors of emergency conversion is essential to establish the safe indication of OPCAB as well as to improve the surgical and anesthetic techniques used to avoid emergency conversion. We reviewed the preoperative risk variables and outcomes of such patients in our short series to determine morbidity and mortality of patients requiring off-pump to on-pump conversion compared with patients having completed OPCAB. And analyzed our experience with emergency conversion in OPCAB.

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MATERIALS AND METHODS

Between June 2006 & June 2007, one hundred and fifty one patients were operated for coronary artery bypass grafting. Seventy seven patients of them had bypass grafting performed on beating heart without the use of cardiopulmonary bypass (OPCAB group). Case notes were analysed to extract necessary data. Anesthetic techniques for the two procedures remained same. Norepinephrine infusion was routinely made available in OPCAB cases for heamodynamic regulation, while the heart was being manipulated during coronary exposure and anastomosis. Octopus-4 stabilizing device (Medtronic Inc. Minnesota) was used to stabilize the cardiac segment where distal anastomoses was constructed. For the CPB cases, myocardial standstill was achieved with enriched cold blood cardioplegia. In the ICU patients were kept ventilated till body

temperature was atleast 34.5°C, patient was haemodynamicaly stable, drainage was settled, patient was conscious and oriented with good arterial blood gases on 40% fractional inspired oxygen. Fluid replacement and serum K+ levels were monitored for first 48 hours following surgery. Use of antiplatelet therapy in the form of Aspirin and/or Clopidogril was noted. Blood loss in the operating room, in ICU, duration of ventilation, number of blood transfusions or blood products were noted. Neurological assessment was made. Apart from demographic details; ventricular function was recorded from echo and angiographic assessment.

OPCAB was performed through median sternotomy. Octopus IV (Medtronic, Inc, Minneapolis, MN) was used to stabilize the beating heart. A bloodless field for distal anastomosis was obtained with proximal silastic snare suture. An air and saline mixture blower was used for better visualization of target vessels. In most cases, the left anterior descending artery (LAD) territory was grafted first, which was followed by either marginal, or right coronary (RCA) or posterior descending artery (PDA).

We defined conversion as a change over to CPB after having mobilized the beating heart for anastomosis; either because of hypotension, ischemia, critical arrhythmias (e.g. ventricular tachycardia/fibrillation) or difficult exposure of target vessel. The reasons of conversion in 7 patients are shown in (Table 1).

Table I

Patient Number	Reason	Status
1	Excessive Epicardial Fat	Elective
2	Hypotension during OM grafting	Emergency
3	Hypotension during OM grafting	Emergency
4	Hypotension during OM grafting	Emergency
5	Hypotension during OM grafting	Emergency
6	Hypotension during LAD grafting	Emergency
7	Hypotension during OM grafting	Emergency

Table II
Demographic Description

n=151	Minimum	Maximum	Mean	Std. Deviation
Weight	47	94	69.66	10.026
Age	28	75	54.01	8.679

Table III
Risk Factors

		Off-Pump	On-Pump	Total	p-Value
Diabetes	Diabetics	15 (9.9%)	13 (8.6%)	28 (18.5%)	NS
Hypertension	Hypertensive	44 (29.1%)	25 (16.6%)	69 (45.7%)	0.004
Hypercholesterolemia	Hypercholesterolemia	40 (26.5%)	43 (28.5%)	83 (55%)	NS
Smoking	Smoker	43 (28.5%)	42 (27.8%)	85 (56.3%)	NS
Type-A Personality	Type-A Person	38 (25.2%)	42 (27.8%)	80 (53%)	NS
Family History	Positive	34 (22.5%)	34 (22.5%)	68 (50%)	NS

Table IV
Pre-operative Profile

		Off-pump	On-pump	Total	p-Value
Vessels Involved	SVD	4	1	5	0.187
	2VD	12	11	23	0.902
	3VD	48	46	94	0.982
	LM	12	15	27	0.453
	LM Equi	1	1	2	0.977
No. of bottom ends	1	3	0	3	0.086
	2	15	7	22	0.081
	3	39	44	83	0.277
	4	19	20	39	0.108
	5	1	3	4	0.292
Urgency	Routine	31	44	75	0.018
	Urgency	32	22	54	0.13
	Emergency	13	8	21	0.281
	Salvage	2	0	1	0.163
Ejection Fraction	Normal	15	31	46	0.003
	Mild	19	16	35	0.657
	Mod	37	22	59	0.021
	Severe	6	5	11	0.807

RESULTS

Altogether 151 cases were analysed. There were 77 patients in OPCAB group and 74 in CPB group. Mean age was 54.01 (SD= 8.67). Average weight of the patients was 69.66 kg {(SD=10.02)Table II}. Sex distribution between the groups is illustrated(Fig.I). Risk profile for coronary disease is presented(Table III). Twelve patients in OPCAB group and 15 in CPB (p=0.453) had critical left main stenosis. Majority in both groups however had triple vessel disease, 48 and 46 respectively(Fig II). Average number of grafts performed per patient was 3.13 {(SD=0.76) Fig III}. There were more sick patients with moderate to severe LV dysfunction in OPCAB group compared to CBP group. Complete pre-operative details are summerised in (Table IV). Seven patients needed conversion to conventional bypass. Of these seven cases three had left main disease, and 3 further had triple vessel disease (Fig IV). Six patients had emergency conversion, one of them was a left main emergency undergoing total arterial grafting. And one had elective conversion (Fig V). The one who had elective conversion needed grafts to LAD and diagonal. But due to excessive epicardial fat it was

felt safe to locate the vessels on a still heart. Of the emergency conversions five patients developed hypotension midway through the OM graft, all these hearts then went on to have ventricular fibrillation. The sixth patient developed haemdynamic compromise while. LAD was being grafted, and also fibrillated later. Cardiac massage was initiated while the standby perfusionist set-up for emergency cardiopulmonary bypass. There were 3 deaths altogether. Two deaths occurred in patients with left main coronary disease and one in a triple vessel disease patient (Fig VI}.

Figure I
Sex Distribution between the Groups

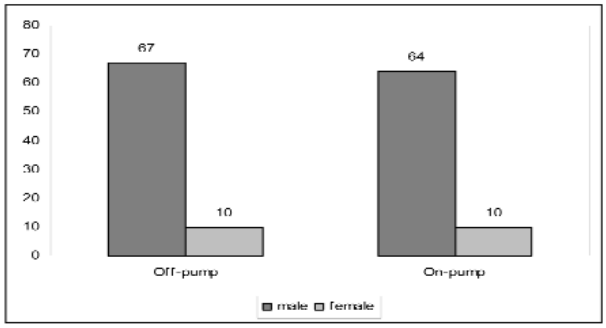


Figure II

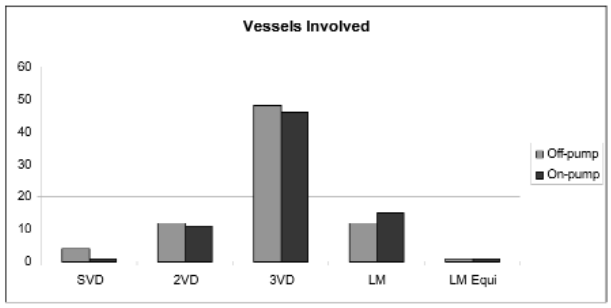


Figure III

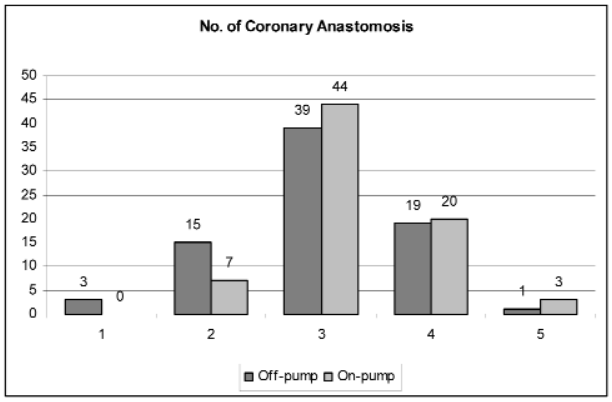


Figure IV
Vessel wise distribution of Conversions

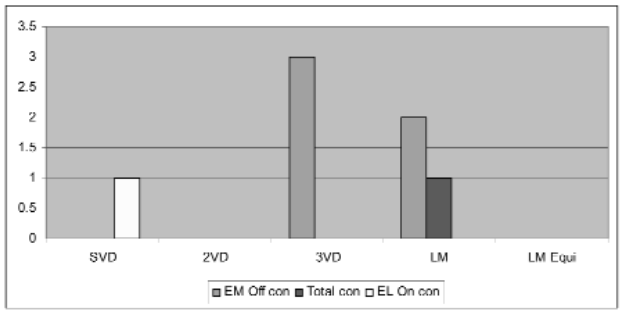


Figure V
Distribution of Conversions

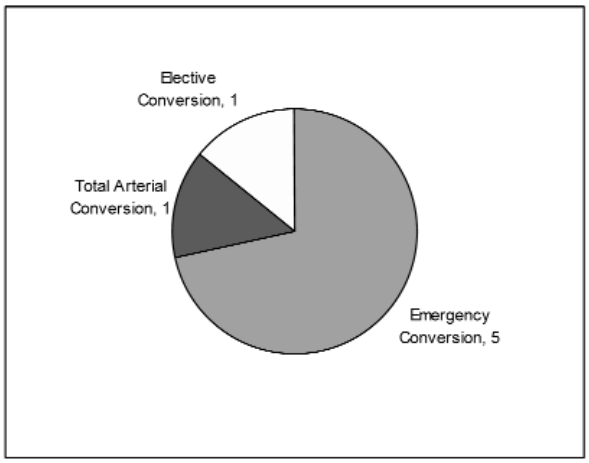
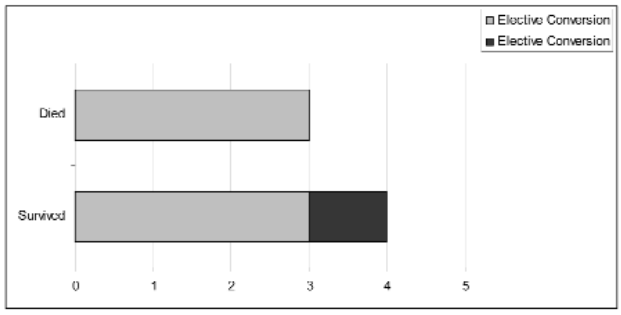


Figure VI
Outcome of Conversion Cases



DISCUSSION

Conversion in OPCAB has been shown to increase mortality and morbidity, and operative mortality has been reported to range from 8.5 to 18%[3-6]. Some studies included elective conversions while others did not. Elective conversion without hemodynamic compromise has been reported not to increase

mortality and morbidity[7]. In our emergently converted OPCAB group, the operative mortality was 46.3%. All these patients could not be weaned from bypass.

Knowing predictors of emergency conversion is very important to establish the safe indication of OPCAB as well as to improve the surgical and anesthetic techniques used to avoid emergency conversion. Edgerton et al. showed that a surgeon who is early in experience of OPCAB techniques is an independent predictor of conversion[3]; a finding also confirmed by Soltoski and associates [7].

Although no study has shown that anesthetic skill is correlated to the incidence of conversion, it seems apparent that experienced anesthetic management is essential for successful OPCAB[8]. Patel et al. concluded that emergency conversion is an unpredictable event and that the incidence of conversion decreases with increasing OPCAB experience of surgeons and use of the heart positioning device[5]. Chang et al. have shown, in a randomized controlled study, that an apical suction device provides less hemodynamic compromise than the deep pericardial sutures during the exposure of the posterior descending artery and the obtuse marginal artery[9]. This finding has been also shown in other animal studies[10]. However, it is well described, that reduction in conversions after the introduction of a heart positioning device could also be due to the increasing experience of surgeons. In our series we can identify the possible causes in our series. Lack of experience to position the heart, non use of intra coronary shunts and possibly less experienced anaesthetic back-up were few salient points. Identifying and addressing to them appropriately has reduced our incidence of emergency conversion.

Congestive heart failure[3,11], redo surgery[3], low EF[11], recent MI[11] have been also been reported to predict conversion Furthermore, body mass index has been shown to predict conversion[6], intracoronary shunt use has been shown to reduce temporary hemodynamic compromise during the distal anastomosis in OPCAB[12], and coronary collaterals were reported to protect against perioperative MI in OPCAB[13]. These factors were not investigated in our study. Further investigation is needed to clarify the effect of these factors on emergency conversion.

Once knowing predictors of emergency conversion, how to prevent emergency conversion in high-risk patients should be considered. Elective on-pump CABG may be a good option when the risk of conversion outweighs the benefit of OPCAB. Otherwise prophylactic use of pharmacologic or mechanical support may be beneficial to avoid emergency conversion. Retrospective studies have shown that IABP is also a useful adjunct when trying to maintain hemodynamic stability in high-risk OPCAB patients[14]. Craver et al. have reported that elective IABP use for high-risk patients provided improved hemodynamic stability and eliminated the need for inotropic support during the dislocation of the heart in OPCAB[15]. In our study, preoperative IABP was not an independent predictor of emergency conversion. A randomized prospective study is needed to assess the effect of elective IABP placement on the avoidance of emergency conversion in OPCAB.

Additionally, judicious use of cardiac monitoring could provide an insight into predicting emergency conversion. Early changes in patient hemodynamics could be noticed before serious compromise and elective conversion could be chosen in such cases. Continuous myocardial pH monitoring, continuous mixed venous oxygen saturation monitoring or continuous wall motion monitoring with TEE might be beneficial for this purpose. Further investigation is required to know the effect of these monitoring interventions on the prevention of emergency conversion in OPCAB.

An important limitation of this study is that it is a retrospective study. Another limitation is the small patient number in the conversion group. A larger study is needed, but the bias of surgical and anesthetic skills should be adjusted even in large studies. The influence of emergency conversion on the late outcome needs to be investigated. We did not compare the outcomes between converted OPCAB and elective on-pump CABG because our number of elective CABG patients was low and selection bias was difficult to adjust for.

When considering the indication for OPCAB patients with mild to moderate ischemic MR, one has to consider not only the risk of conversion but also the need to perform a concomitant mitral valve repair; this remains controversial, so we have elected to omit

it from this discussion. Currently we perform OPCAB in patients with mild to moderate MR if there is no indication of mitral valve repair (our indication for doing a concomitant mitral valve repair is outlined above); additionally, during the procedure we carefully monitor the pulmonary artery pressure, the severity of MR via a TEE and other vital parameters, and electively convert to CPB if they become worse.

CONCLUSION

In conclusion, emergency conversion to CPB increases operative mortality and morbidity in off-pump coronary artery bypass grafting. Use of a heart positioning device might decrease emergency conversion due to hemodynamic compromise during anastomosis in the circumflex artery territory.

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