

## **Off-Pump Coronary Surgery – Results of Over 100 Cases Done by Trainees in a Single Institution Over One Year**

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### **INTRODUCTION**

Beating heart surgery is now an established procedure for myocardial revascularisation. With improvements in technique and technology it is now possible to safely perform off-pump surgery in almost all patients referred for CABG – both elective and non-elective [Roy 2001, Varghese 2001]. It has been demonstrated that off-pump surgery can be safely taught to trainees, but these cases were selected [Karamanoukian 2000, Caputo 2001]. For off pump surgery to be accepted as mainstay treatment, it is necessary to demonstrate that junior surgeons can achieve good results operating on non selected patients. In this context it should be noted that previously reported good results with off pump surgery may reflect the fact that operations have been carried out by very experienced surgeons [Hart 2000]. In our institution the trainees traditionally do high risk and non-elective cases. Once they have been trained in off-pump surgery techniques, the trainees exercise their own judgement as to whether an individual case is better done on or off pump. The results of cases done by these trainees are therefore relevant and applicable to the majority of cardiothoracic surgeons.

### **MATERIALS AND METHODS**

From January to December 2000, 378 isolated coronary bypass cases were performed at our institution; 201 were off-pump and 107 (58%) of these were performed by the trainees. The cases consisted of 73 males and 34 females; 32 cases were non-elective and 2 cases were redos. The demographics of the patients are shown in Table 1 (Age, sex, left ventricular (LV) function; presence or absence of diabetes, renal disease, peripheral vascular disease or central nervous system (CNS) problems; elective, non-elective or redo status). One quarter of the patients were aged 70 or over and one fifth (23/107) had a Parsonnet score greater than 11. The average predicted mortality from Parsonnet was 8.9% and from EuroScore was 5.2%.

<b>Total</b>		107
<b>Age</b>	40 - 49	5
	50 - 59	34
	60 - 69	41
	70 - 79	24
	80 - 80+	3
<b>Sex</b>	Male	73
	Female	34
<b>Diabetes</b>	No	57
	Yes	50
<b>Renal function</b>	Normal	79
	Cr >200	20
	On dialysis	8
<b>CNS history</b>	No	87
	Yes	20
<b>Peripheral vascular Disease</b>	No	90
	Yes	17
<b>LV function</b>	poor <30%	12
	fair 30 - 50%	54
	good >50%	41
<b>Priority</b>	Elective	75
	Non elective	32
<b>Redo</b>		2
<b>Average Parsonnet predicted mortality</b>		8.90%
<b>Average Euroscore</b>		5.2%

**Table 1 – Patient demographics**

All cases were performed through a midline sternotomy. Heparin (1-2mg/kg) was administered to keep the ACT greater than 250 seconds. Blood pressure was maintained during the procedure by a combination of Trendelenburg, volume and low-dose adrenaline. Stabilisation was obtained using a number of different retractors but predominantly Octopus 3 (Medtronic Inc, Minneapolis, MN) and CTS Vortex (Cardiothoracic Systems, Cupertino, CA).

To optimise exposure of vessels and minimise hemodynamic compromise, a 2/0 silk stitch was inserted onto the posterior pericardium between the left lower pulmonary vein and the inferior vena cava. This was snugged and the snugger manipulated to achieve optimal positioning of the heart including verticalization. The right pleura was opened and the pericardium incised to the level of the IVC in those cases requiring grafting of target circumflex vessels.

Control of bleeding from the arteriotomy site was achieved using proximally placed silicone elastomer vessel loops (Quest Medical Inc, Allen, Tx); a CO<sub>2</sub> blower (Medtronic DLP, Grand Rapids, MI) was also used to aid vision. Intraluminal coronary shunts (Biovascular Inc, St Paul, MN) and distal snares were used infrequently (<10% of grafts)

The first anastomosis performed was usually the internal mammary to the left anterior descending artery. All the distal anastomoses were commonly performed before the proximal anastomoses. The proximal ends were sewn to the aorta over a partial occlusion clamp. Before applying the partial occlusion clamp the systolic blood pressure was lowered to below 80 mm Hg pharmacologically, or by temporarily clamping the IVC. The partial occlusion clamp was of a size sufficient to allow all the proximal anastomoses to be constructed with a single clamp. After completion of the last anastomosis, heparin was reversed with Protamine.

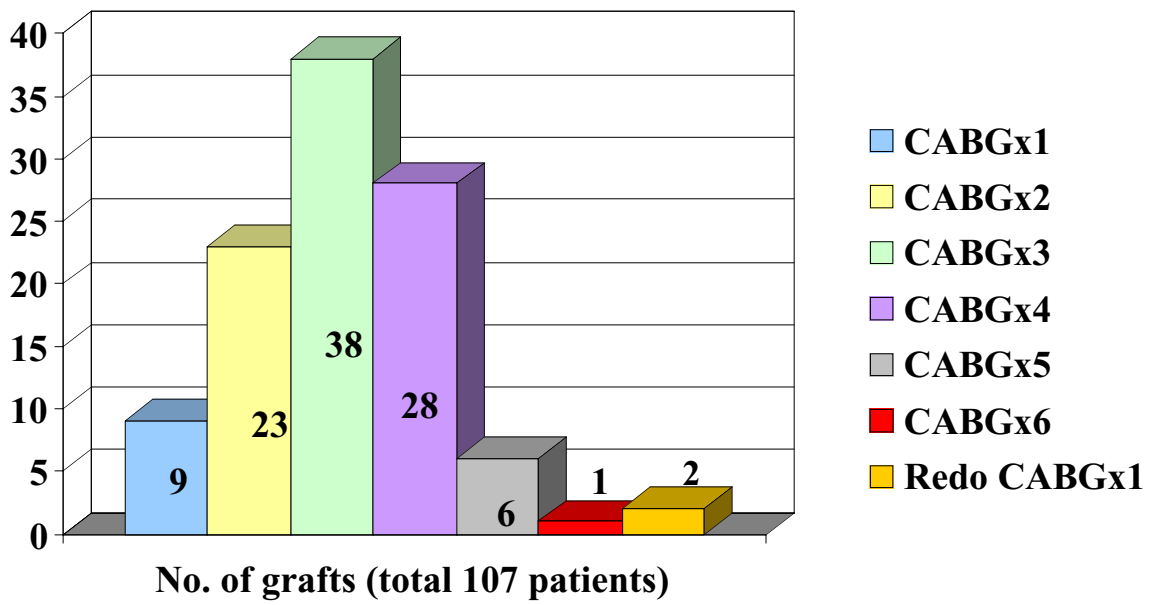


Figure 1

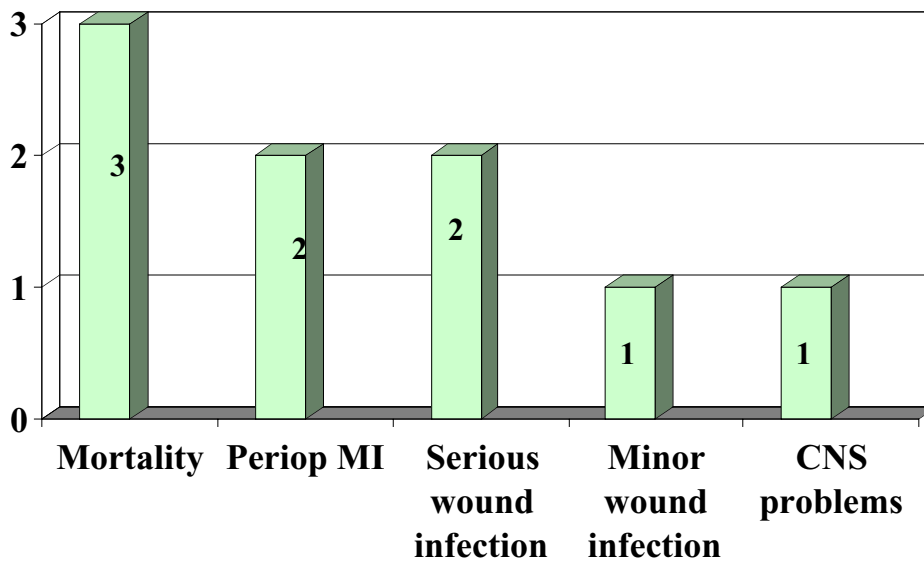
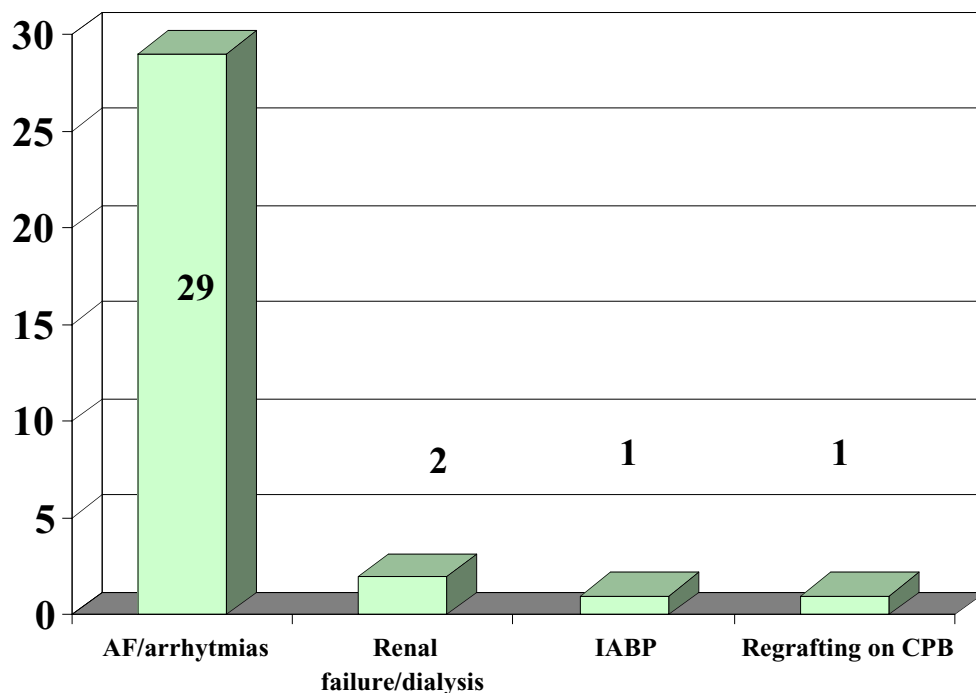


Figure 2



**Figure 3**

## RESULTS

A total of 319 grafts were constructed with a mean of  $2.98 \pm 1.09$  (range from 1-6), 2 of the cases were redos (Figure 1). There were 3 deaths (2.8%) in the series as compared to a predicted mortality of 8.9% (Parsonnet) and 5.2% (Euroscore). There were 2 perioperative MIs of which one patient required an IABP. This patient also required regrafting on CPB and developed renal failure and a stroke. The complications are shown in Figures 2 and 3. Of the 104 survivors, 55 (53%) were discharged within 4 days of surgery and 92 (88%) within 7 days of surgery. There were 3 readmissions; all for wound infections (2 sternal and 1 buttock abscess). Three patients who are not included in this evaluation started as off-pump and were converted to on-pump at an early stage.

## DISCUSSION

Over the last 30 years coronary artery bypass grafting with the use of cardiopulmonary bypass has become accepted as the gold standard for the

treatment of coronary artery disease [Bonchek 1998]. The recent introduction of off-pump surgery has however now challenged this standard. With increasing experience, proponents of off-pump surgery claim that it is superior to cardiopulmonary bypass and therefore should be the operation of choice for patients undergoing CABG [Mack 1999].

In keeping with other institutions over the last year, the practice of off-pump surgery has increased at our hospital to the extent that in one consultant's practice almost all cases are now done off-pump [Roy 2001]. To address the issues of the applicability of this technique to the majority of cardiothoracic surgeons we have looked at the 1-year results for 2 trainees at our hospital. In our institution the trainees traditionally do high risk and non-elective cases. Once they have been trained in off-pump surgery techniques, the trainees exercise their own judgement as to whether an individual case is better done on or off pump.

In our opinion the human patient is not the ideal model for a surgical trainee to perform their first anastomosis. A model has been developed for trainees to practice performing anastomoses, and this can also be used to simulate off-pump conditions [Stanbridge 1999]. Both trainees practiced on this model, and verified the accuracy of their anastomoses before doing any clinical cases. Prior to January 2000 one of the trainees had done a few off-pump anastomoses; by the end of the year this trainee was performing approximately 90% of his cases off-pump. The other trainee did his first off-pump case in May 2000 and by the end of the year was doing approximately 75% of his cases off-pump. It should be made clear that both trainees were fairly experienced, each having done more than 250 cases as the primary surgeon, prior to starting their off-pump series.

Once they had been trained in off pump techniques the trainees were allowed to exercise their own judgement as to whether they wished to perform a case on or off pump. In some cases this was due to individual preference but in many cases the off-pump technique was chosen because it was clearly believed that it was the superior technique. For example one of the trainee cases was a 79-year-old lady who had undergone previous CABG and was admitted with unstable angina. Cardiac catheterisation revealed that she had a very tight proximal LAD stenosis and this was the only graft she needed. As the LIMA had not been used previously, the trainee's opinion was that an off-pump LIMA graft to the LAD was the operation of choice. This choice was justified by an uncomplicated, quick operation with the patient being discharged on the 6<sup>th</sup> postoperative day.

The mortality achieved by the trainees is lower than that predicted by either Parsonnet or Euroscore. These good results probably reflect the fact that several of the patients in this series were in categories where off-pump surgery has been shown to be superior to conventional CABG e.g. poor left ventricular function [Boyd 1999, Arom 2000, Jegaden 2001, Stamou 2001]. The morbidity in this series is also low. The majority of serious complications occurred in just 2 patients. One required regrafting on CPB, had an IABP inserted, suffered a perioperative MI, stroke and renal failure. The other patient who developed renal failure also had mediastinitis. The low incidence of operative and post-operative complications is evidenced by the fact that just over 50% of patients were discharged within 4 days of surgery and nearly 90% within 7 days. This compares very favourably with the 1998 STS Database, which reported that only 82% of patients were discharged home within 2 weeks with a 10% 2-month readmission rate. In our series there were only 3 readmissions which were all for wound infections.

It has been rightly pointed out that one of the reasons why conventional coronary artery bypass grafting is accepted as such a good operation, is the predictable relief of angina and the low incidence of reintervention [Bonchek 1998]. The results from the Minneapolis group are therefore disconcerting [Arom 2000].

They reported that the incidence of recurrent angina was almost treble, and the incidence of PTCA five times higher, in-patients done off-pump compared to those done with CPB. There are several possible explanations for this difference. As off-pump anastomoses are technically more difficult to perform it could be attributed to poor or failed grafts. However studies have demonstrated very high patency with grafts performed off pump [Bull 2001, Puskas 2001]. It could also be due to other technical factors causing endothelial damage; these include intra-luminal shunts, distal snares and the CO2 blower [Okazaki 2001]. We rarely used distal snares or intra-luminal shunts. The CO2 blower was used but it was humidified and used sparingly. In our opinion the most likely reason for recurrent angina is incomplete revascularisation. In our institution our practice is to graft all vessels greater than 1 mm in diameter with significant stenosis. Based on this criteria in our opinion total revascularisation was achieved in all patients. We do not have any data on recurrence of angina in this series of patients, but are currently looking at the 1-year angina recurrence rate in all off-pump patients done by one consultant.

## **CONCLUSIONS**

The results from our institution indicate that junior surgeons competent in coronary artery bypass surgery can safely achieve complete revascularisation off-pump in the vast majority of patients referred for surgery. The low mortality in this series is compatible with previously reported series demonstrating that the technique is superior to cardiopulmonary bypass in “high-risk” patients. We also demonstrated a very low incidence of complications and a high percentage of early discharge. We cannot however comment on the mid to long term results of the procedure and these will of course be important in deciding whether this procedure should be utilised in preference to cardiopulmonary bypass in individual patients.

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