

Multi-Vessel Off-Pump Coronary Artery Bypass Grafting Can Be Taught to Trainee Surgeons

(#2001-8877 ... June 27, 2001)

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Presented at the Fourth Annual Scientific Meeting of the International Society for Minimally Invasive Cardiac Surgery, June 27-30, 2001, Munich, Germany.

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ABSTRACT

Background: Although, Off-Pump Coronary Artery Bypass (OPCAB) surgery is being increasingly explored and practised in many cardiac units worldwide, there have been only few reports documenting the training of surgeons in this new technique. The purpose of this study was to address the reproducibility of the OPCAB in a unit where this technique is used extensively.

Methods: Registry data, notes and charts of 64 patients who were operated on by four trainee cardiac surgeons over a period of thirteen months at Harefield Hospital, were reviewed retrospectively. These trainees were part of an accredited training programme for cardiothoracic training and were trained by a single consultant trainer in a cardiac unit after it has had an established recent experience in performing non-selective OPCAB for all coming-in patients. Five (7.8%) patients (with 17 distal anastomoses) consented and underwent early postoperative angiography to check the quality of the grafts and anastomoses.

Results: The mean age of the study patients was 65.6 and the mean Parsonnet score was 9.4. There was a mean of 2.9 grafts per patient and

circumflex territory anastomoses were performed in 48 (75%) patients. No operation required conversion to Cardiopulmonary Bypass (CPB). Angiography of the five patients revealed satisfactory seventeen (100%) distal anastomoses.

Conclusion: With appropriate training, it is possible for trainees to learn OPCAB and perform multi-vessel revascularization in relatively high-risk patients with good results.

INTRODUCTION

Over the last five years there has been increasing interest in surgical coronary revascularisation without using Cardiopulmonary Bypass (CPB). Although the basic principle is not new and considerable experience has been reported years ago [Buffolo 1990], the recent enthusiasm has been stimulated by technological advances in the stabilisation techniques [Jansen 1998]. Many reports from both side of the Atlantic have demonstrated excellent early and mid term results, and the technique is considered safe [Calafiore 1996, Spooner 1999].

However, to date, there are few randomised trials comparing Off-Pump Coronary Bypass surgery (OPCAB) with conventional Coronary Artery Bypass Grafting (CABG) utilising the CPB [Ascione 2001]. As the OPCAB procedure is relatively new, the long-term graft patency and patient survival remains unknown. Although there are theoretical reasons why coronary revascularisation without CPB may be beneficial in some patients, it has not been conclusively demonstrated that OPCAB offers any significant benefit in all patients. Some would argue that we have spent the last 40 years refining CPB, myocardial protection and CABG so that the excellent outcomes achieved today with the standard operation should not be jeopardised [Bonchek 1998, Jegaden 2001]. CPB allows optimal conditions to enable proven reproducible results by a large number of cardiac surgeons in all patients. Nevertheless, a minority of patients

continue to suffer from significant morbidity following CABG and therefore new methods of improving outcome must continue to be tried and evaluated [Mack 1999]. It is unlikely that any definite conclusions will be possible until long-term outcome data becomes available and the randomised trials currently in progress begin to be reported in the next few years [van Dijk 2000]. However, the encouraging data from the pioneering units has already stimulated a rapid expansion in beating heart surgery.

The teaching of new operative techniques, to both junior trainees and senior surgeons, is always a difficult issue and a surgeon's 'learning' curve should not disadvantage any patient. Without training of the next generation of surgeons and continuing refinements, new procedures could never be proven or widely accepted in clinical practice. It has been cautioned that OPCAB is not a procedure for any surgeon performing CABG and that only a minority of trained surgeons with above average technical skills may ever master it [Bonchek 1998]. However, evidence from one established programme suggests that OPCAB can be successfully taught to trainee surgeons and could be integrated into residency programmes in the USA [Karmanoukian 2000]. Surveys of trainees in the UK and USA suggest that they are keen to learn [Ricci 2000, Yap 2000]. If OPCAB is proven to have advantages over conventional CPB, even if only for selected patient subgroups, it should be available in all cardiac surgical centres and therefore training strategies should be formulated. We present a retrospective analysis of trainees' OPCAB experience over a thirteen months period, trained by a single consultant trainer.

MATERIALS AND METHODS

Data Collection

All OPCAB operations performed by surgical trainees supervised by one consultant (MA) at Harefield Hospital from January 2000 till February 2001 were traced from trainee logbooks, operative room records and the Patient Analysis & Tracking System (PATS) hospital local database. The patient case notes, including the six-week clinic follow up record, were examined for operative and postoperative data. Follow-up information was available on all patients.

Surgical Training

Trainees spent six months at this cardiac surgery unit as part of a six-year specialist cardiothoracic accredited training programme at four London teaching hospitals. Trainees spent two months doing OPCAB procedures with one consultant who supervised their training during this time. During the period of the study, four trainees (3 senior and 1 junior) were assigned to the unit. Depending on previous experience in coronary surgery the trainees progressed at different rates. All trainees started by assisting the trainer, followed by Left Internal Thoracic Artery (LITA) to the Left Anterior Descending (LAD) anastomoses under close supervision and gradually progressing to multi-vessel cases. This series includes consecutive OPCAB operations where the trainee performed the whole operation, including all grafts, under the supervision of the senior author (MA).

Operative Technique

Anaesthesia was induced using Propofol 1-2 mg/kg, Pancuronium 0.1 mg/kg and Fentanyl 8-15 µg/kg. Then was maintained by air/oxygen and Propofol 2-3 mg/kg/hr. Anticoagulation was achieved using 150 U/kg of Heparin

given after completion of harvesting the Internal Thoracic Arteries (ITAs). The Activated Clotting Time (ACT) was always maintained above 250 seconds. Trans-Esoophageal Echocardiography (TEE) was used for additional monitoring as required. Normothermia is maintained by using warm intra-venous fluids, heating mattress and a humidified airway; in addition to maintaining a warm operating theatre. A standby perfusionist with primed bypass circuit was available for all cases.

A standard midline sternotomy incision is used to expose the heart. The pericardium is opened using an inverted T-shaped incision following the harvest of the ITAs. The right pleural space is opened to create a space for the rotated and verticalized heart to minimize haemodynamic compromise.

Operations were performed using the Medtronic Octopus II/III suction stabiliser (Medtronic Inc, Minneapolis, MN). One deep pericardial retraction suture is placed at the posterior fibrous pericardium very close and medial to the most proximal part of the Inferior Vena Cava (IVC). This suture is a personal modification (MA) of previously described deep pericardial retraction sutures. It acts as a lever that helps the surgeon manipulate and rotate the heart to vertical and lateral positions along with the Octopus[®]. A wet gauze swab is placed between the suture and the posterior surface of the heart to avoid tearing the myocardium or compressing of the posterior coronary vessels.

Prolene coronary stay sutures were carefully placed to isolate the site selected for anastomosis and intracoronary shunts were not utilised routinely. Anastomoses to coronary arteries were performed in the standard fashion using continuous 8/0 prolene for the ITA and 7/0 for other conduits. Proximal anastomoses were to the ascending aorta or to a pedicled ITA. The order of grafting was LAD, Right Coronary Artery (RCA) or branches thereof, and finally Obtuse Marginal (OM) branches.

Angiograph

Five (7.8%) randomly selected patients consented and underwent angiography before discharge at the earliest on the fourth postoperative day, aiming to look at quality of anastomoses and patency of grafts. All the angiograms were performed and commented on by one cardiologist (MB). An Institutional approval was obtained for the study.

Statistical Analysis

Continuous data is described with the mean and standard deviation. Where data did not show a normal distribution, ranking was used and the median and interquartile ranges quoted.

RESULTS

Sixty-four OPCAB operations were performed by trainees under the supervision of one trainer (MA) over the period of this analysis. This comprised 25% of the total OPCAB series (256 operations) over the thirteen-months period of the study.

The median patient age was 65.6 (range 38-83) and 44 patients were males. Patients were not specifically selected for OPCAB or for trainees and the mean Parsonnet score was (9.4 ± 8.7) with a median of 7. Thirty-eight operations (59.4%) were performed on elective patients, and 26 (40.6%) on patients referred 'urgently' as in-patients because of unstable angina or significant stenosis of the left main stem.

There were no conversions to CPB. Overall, there was a mean of (2.9 ± 0.8) grafts per patient (range 1-4, median 3) even though four patients required

only a single graft. Forty- eight (75%) of the 64 patients had grafts to circumflex artery branches and Forty- eight (75%) patients had full arterial revascularisation.

The median length of stay was 7 days (IQR 2). At initial follow up (6 weeks post discharge) all patients were free from angina and none had required re-admission to hospital.

There was only one non-cardiac related post-operative death. The cause of the death was small bowel perforation and peritonitis that could not be saved by the general surgeons. Morbidity was recorded in 13 patients and included: 4 respiratory infections required a course of antibiotics; 4 episodes of atrial fibrillation; 3 superficial sternal wound infections; 2 impaired renal function with a creatinine rise [$> 200 \mu\text{mol/l}$]; 2 reoperations for postoperative bleeding and 2 required low dose inotropes for blood pressure support. None of the patients had any neurological complication nor peri-operative Myocardial Infarction (MI).

Angiography of the five (7.8%) randomly selected patients revealed that all the grafts were patent as confirmed by two orthogonal views, which included seventeen distal anastomoses that were satisfactory in terms of technique, patency and flow. All the grafts were of acceptable calibre and no string-effect was noted.

DISCUSSION

This retrospective report documenting our early experience with the introduction of a training programme for coronary revascularisation using the Off-pump technique shows that multi-vessel OPCAB surgery can be taught to surgical trainees with good clinical and angiographic results. It should be emphasised that training was only commenced after the senior author (MA), anaesthetists, theatre staff and the institution had become experienced and confident with the technique. It should also be understood that three of the

trainees had already performed in excess of a hundred CABG procedures with CPB before commencing the OPCAB training.

Patients in this series were not selected for OPCAB nor selected for trainees, as the demography illustrates; they represent a consecutive sample of the on-going workload of a busy unit with long waiting lists. Although, as with any retrospective series, it is true that there might be some surgeon bias and inadvertent risk stratification performed at the time so that seniors operated on patients deemed at highest risk or with particular technical challenges. The mean Parsonnet score was relatively high (>9.4) and more than half of the patients were urgent cases. None of the patients was especially selected because of particular coronary anatomy. Four patients only required single grafts to vessels that were not favourable for Percutaneous Transluminal Coronary Angioplasty (PTCA) or stenting, but despite this, the median graft number was almost three. We believe that although the patient population in this study was relatively small with only early clinical and angiographic follow-up data, it still represents the 'real life' experience of teaching trainee surgeons within a busy coronary surgery practice fully committed to OPCAB revascularization.

We have demonstrated that the training of junior surgeons can continue uninterrupted in a practice with a high workload where coronary surgery is almost totally converted to OPCAB. It was therefore not possible to contrast these results directly with a concurrent series of trainee operations on CPB. However, a much larger retrospective series from another London hospital on the same training rotation does allow some comparison. Over a six-year period, trainees performed 1911 CABG operations on CPB. The mean Parsonnet score was 5, the median number of grafts was three and the mortality less than 3% (14). Because of the relative novelty of this technique, the perceived technical challenges and the limited outcome evidence, OPCAB has not been universally

accepted in all cardiac centres. Now that the pioneers have successfully popularised the technique, more units are commencing their OPCAB programmes, and the initial procedures are usually performed on the least complex patients by fully trained surgeons. Therefore, the trainers are operating on the patients who previously would have been revascularized on CPB by supervised trainees. Many trainees are concerned that they will get limited exposure to OPCAB and also less experience in conventional CABG as their trainers refine their own techniques and accumulate experience. The only other institutions to report the experience of trainees with OPCAB surgery have had established programmes for a longer time [Karmanokian 2000, Caputo 2001]. The experience from Buffalo has been broadly similar with 61 OPCAB cases performed by one resident over an eighteen month period with an average of 2.4 grafts per patient. Like our case series, there was no evidence of special selection for OPCAB although, there were more grafts performed in the operations the resident performed on CPB.

We concur with their conclusion that technical innovation has made OPCAB effective and safe enough for less experienced surgeons to be taught the relevant skills. Others reported 124 trainee OPCAB operations over a 3-year period [Caputo 2001]. The outcome for supervised trainee operations did not differ from that achieved by experienced seniors. We agree that this represents further evidence that beating heart surgery can be successfully taught, and that the best time to learn these techniques is when fully supervised at an early stage in operative training and when the technique has already been established in the unit where the training is planned to happen. We would also emphasise that training centres and senior trainers must be experienced and confident with the technique and that all hospitals may be able to provide the correct environment. The above experience is not yet uniform across the USA nor in the UK. A recent

survey of all 327 US cardiothoracic residents demonstrated that only 12% had performed more than 20 complete OPCAB cases during their training and only 4% had performed more than 20 circumflex grafts [Ricci 2000]. Despite such limited experience, 98% of the residents who replied were interested in OPCAB and 88% saw themselves performing OPCAB during practice.

The latter data may be a cause for concern since there seems to be an evolving enthusiasm that is not yet fully evidence based. At present, the anticipated benefits of reducing the morbidity of CPB, especially with regard to renal and cerebral dysfunction are not proven. Neurological morbidity after CPB remains a controversial issue [Newman 2001], but there is no proof that OPCAB operations reduce the incidence of stroke or neuropsychological dysfunction [Kshetry 2000].

We suggest that there is sufficient evidence to prove that OPCAB can be taught to trainees. Whether or not one believes in the principle and efficacy of beating heart surgery, there is now data to demonstrate that trainees can acquire the relevant skills, as reflected by our clinical and angiographic data. We are not advising that every trainee should perform all bypass grafts with the OPCAB technique. There is probably still a place for the, real or perceived, additional security of conventional CPB for the first training procedures in most institutions. However, the skills learnt in OPCAB surgery; in safe manipulation of the heart, more consciousness of patient haemodynamics and the need for efficiency in performance of anastomoses equip the trainee with greater understanding and confidence required for all cardiac procedures. Over the next five years the surgical and cardiological community should be able to establish the place of OPCAB surgery in the treatment of ischaemic heart disease. When the indications for OPCAB surgery are finalised and accepted, we hope there will be an adequate number of sufficiently trained surgeons available for it to become

widely applicable. We suggest that junior surgeons can be taught these techniques and that this training should continue in the centres with a special interest in beating heart surgery.

Although the data used in this analysis was entered prospectively into the PATS database, this remains a retrospective study and suffers from the deficiencies of any retrospective analysis. The number of procedures reported here is relatively small, however, this experience of trainees with OPCAB is greater than in many other European centres. The follow-up is necessarily short as trainees only began performing OPCAB procedures since the beginning of 2000. Another limitation of the study, is the unavailability of any objective data regarding the quality of anastomosis or graft flow as a means of quality control, since this requires an especially designed prospective study.

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