OFF-PUMP BEATING HEART CORONARY ARTERY BYPASS (OPCAB)
Initial Experience at King Khalid University Hospital King Saud University

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The development of new mechanical stabilizer in the market encouraged a lot of surgeons to practice offpump coronary artery bypass as this procedure avoids all the possible risks of cardio-pulmonary bypass, an essential element in the conventional coronary bypass operations. During a period of 50 months, the cardiac surgery unit in King Khalid University Hospital performed 85 cases of off-pump coronary artery bypass. The average number of graft was 3.1 per patient. The immediate hospital mortality was 2% to 3%. Conversion rate to conventional coronary artery bypass was 5.8%. Conclusion: Off-pump coronary artery bypass is a valid option with minimum morbidity and mortality in most subsets of patients. Acute ischaemia and diffuse disease patients are definitely not suitable for this procedure.

THERE IS A GENERAL TREND IN CARDIAC SURGICAL centers towards minimally invasive approaches. However, we have to differentiate between minimally invasive cardiac surgery and minimal access cardiac surgery, as the latter approach has been widely misused and probably abused by not a small number of surgeons in their excitement to get access to the heart using as tiny wounds as possible, but, unfortunately ignoring how heavily invasive the procedure might be.

Our understanding of minimally invasive cardiac surgery entails as first priority eliminating the hazards of cardiopulmonary bypass when it is not necessary or when we think that it might be harmful to the patient.

As we all know, Mid CAB Surgery was the initial footstep towards minimally invasive cardiac surgery, however, time has shown it to be of narrow applicability. The development of many types of mechanical stabilizers stimulated us, among other centers, to apply this technology in trying to completely revascularize ischemic patients through a full access median sternotomy and without using the pump, the so called off pump beating heart coronary artery bypass (OPCAB).

Material and Methods

During a period of 50 months, a total of 85 cases of off-pump coronary artery bypass operation (OPCABG) were done. The first 20 cases were chosen based on the surgeon's selection of cases. The same surgeon did all cases except four. The following 65 cases were chosen based on exclusive criteria that was developed later on during the experience. All patients with diffuse disease and calcified vessels were excluded. All patients with unstable left main disease or cardiogenic shock were also excluded. The technique that was used in all of these cases was a full median sternotomy. Initially, we used a bolus of 10,000 IV of heparin, which was not reversed at the end of surgery, but lately we are fully heparinizing these patients and this is fully reversed at the end of surgery. We routinely use CTS stabilizers (cardio-thoracic system) and the Octopus 11 (Medtronic) system to stabilize the myocardium in these cases. For exposure, we temporary occlude the target artery using 4/0 prolene suture, however, intra-arterial shunts are routinely used during right coronary artery occlusion. Preconditioning was done in few cases initially but since the introduction of shunts preconditioning is not practiced in our center anymore. Suitability for

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OPCAB is assessed once the pericardium is opened. Reduction in mean pressure during lefting the heart to graft the circumflex artery is compensated by putting the patient in extreme Trendelenberg position and using the LIMA sutures, and in few cases by using a small dose of Dopamine.

**Results**

The total number of grafts done using this method was 240, with a mean of 3.1 grafts per patient. Four and five grafts were done in many patients (Table I), however, two and three grafts per case were the most common scenario.

Table I. The frequency of off-pump CABG according to the

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The total operation time was 90 to 220 minutes with a mean of 155 minutes per case. The ischemia time per graft was 8-22 minutes with a mean of 15 min graft. The ICU stay was 6h to 54h with a mean of 30h per patient. The total hospital stay was 5 to 13 days with a mean of 9 days per patient. Two patients died in the immediate postoperative period, making the hospital mortality 2.3%. Both patients showed early evidence of extension ischemia and in both patients re-grafting was done for occluded grafts. Both cases had diffuse disease with small vessel < 1.25 m in diameter. Both patients sustained massive infarction and low output not responsive to resuscitation. Five cases were converted intraoperatively to conventional CABG due to failure to complete the procedure using the off pump technique.

**Discussion**

Coronary artery bypass grafting (CAB G) has come full circle. Prior to the introduction of cardiopulmonary bypass (CPB) CABG procedures were performed on a beating heart. However, the emergence of CPB and methods of myocardial protection revolutionized CPBG procedures by providing a bloodless, motionless heart. CPB has allowed almost all surgeons to perform a safe operation with excellent graft patency rate. Despite the success of CABG with CPB, the deleterious effects of CPB are well documented. At the same time, surgeons like Buffolo and Benettil-3 have shown in their respective studies, each with a large series of patients, that beating heart CABG can be performed safely with results similar to those with CPB. The advances in the technology of mechanical stabilizers and micro arterial shunts are facilitating a near motionless and bloodless operative field to ease the technical difficulties in beating heart operations. We, among other centers, were able to share in our series of patients the benefits of off pump CABG in minimizing the well known co-morbidities of cardiopulmonary bypass including stroke and neurological complications, and the systemic inflammatory response leading to bleeding, renal insufficiency and pulmonary dysfunction.

Clinical studies comparing outcomes of beating heart CABG and CABG with CPB have reported that patients undergoing beating heart CABG have benefited in other ways, they have a shorter hospital stay, shorter ventilatory support, less blood loss and need for transfusions, fewer arrhythmias, fewer neurological complications and last but not least, more potential of cost saving.

In our series of patients, we had two early mortalities which were directly related to early grafts occlusion leading to myocardial infarction and low cardiac output. In both patients, the target vessels were diffusely diseased and more than one vessel per patient was less than 1.25 in decimeter. The presence of diffuse disease and small vessels have evolved as a standard exclusive criteria from beating heart CABG in our unit and not surprisingly in many other units.

Among the other exclusive criteria that we have adopted are patients with unstable angina and significant left main stem disease and patients with cardiogenic shock. We believe that these conditions are of different pathological etiology and they do not tolerate further acute ischemia.

In our series, we had 5 cases during which the procedure was abandoned and converted to a conventional CABG on CPB. Two of these cases were due to brady arrhythmias during occlusion of the main right coronary artery when no shunts were used. The other three cases were due to low cardiac output and distention of the heart during trials to graft the obtuse marginal arteries. The new introduction of the pericardial retraction sutures assist lefting the heart with minimal hemodynamic
disturbance. LIMA sutures have tremendously helped us to completely revascularize the back of the heart in these patients. It is very clear to us now that beating heart CABG will always face the challenge of grafting the obtuse marginal artery without serious hemodynamic problems in some cases. We are currently evaluating a new right heart assist device designed to alleviate the reduction in cardiac output during lefting of the heart which is now believed to be due to obstruction of the right ventricular outflow tract.

Although initially, and like other units, we had some technical difficulties to master a new and different procedure, we feel at ease now performing multivessel beating heart CABG and currently every patient not in the exclusion list is considered a possible candidate for beating heart CABG. As a word of caution to surgeons starting to do this procedure, we advice them to start with easier grafts and maybe with the heart partially vented on CPB then to proceed to perform grafts on a non-vented heart as off CPB. One should choose excellent target arteries and conduits. It is fair here to mention that the totally occluded left anterior descending artery going to a partially non viable muscle should probably be the surgeon's first target artery to start beating heart CABG. It is also fair to say that the apparently easy right coronary artery with a non-critical occlusion is in a lot of times a very tricky vessel where temporary occlusion and the use of no shunts almost always produces serious brady arrhythmias that may frequently impose unnecessary conversion of the procedure to a conventional CABG on CPB. The use of shunts is essential in these cases and when not available, preconditioning might be of some help.

Conclusion

We believe that off-pump coronary artery bypass is here to stay. It is a surgical technique that unfortunately needs a longer learning curve than conventional CABG. The cardiopulmonary bypass related problems cause increased risk at least in some subsets of patients and off-pump surgery avoids a lot of these risks. However, off-pump CABG has its own limitations and can be very costly if not carefully adjusted to the right category of patients.

References