Off Pump CABG (OPCAB)

The conduct of anesthesia is critical to the success of "beating heart" CABG, which is performed without cardiopulmonary bypass. For this reason, the procedure is called "Off-Pump CABG" or "OPCAB". During OPCAB, venous return, cardiac output, cardiac rhythm and hemodynamics can change rapidly because of extreme cardiac manipulation (for exposure) and subsequent regional ischemia. In contrast to CABG procedures that use CPB, the anesthesiologist is responsible for maintaining stable hemodynamics and rhythm during the period when the surgeon is performing the bypass grafting. Continuous and coherent communication with the surgeon is critical in order to stay abreast of impending insults to venous return and cardiac output. The surgeon must communicate to the anesthesiologist when the heart is being displaced, when a coronary artery is occluded, and when a shunt has been inserted or removed. Likewise, the anesthesiologist must keep the surgeon informed about the use of inotropic and vasoactive medications, ST segment or rhythm changes, hypovolemia and/or new regional wall abnormalities demonstrated on TEE. In no other cardiac procedure is it more important for the anesthesiologist to continually observe and treat the hemodynamic and rhythm responses to cardiac manipulation and regional ischemia.

Proper patient selection is an important determinant of success. For example, coronary targets should be accessible and of adequate diameter. Ejection fraction should be adequate to allow the patient to tolerate the degree of cardiac manipulation required for exposure during the case. Patients with a CI of <2.0, even after "tuning-up" after induction and prior to OPCAB, may be at greater risk of not tolerating OPCAB.

The use of short-acting anesthetic agents for induction and maintenance allows for earlier emergence from anesthesia and the possibility of early extubation. The possibility of earlier extubation is enhanced by the reduction in pulmonary complications provided by off-pump CABG. (The majority of current protocols for managing patients undergoing OPCAB emphasize the following strategies: avoidance of beta-blockers (maintain adequate cardiac output with normal heart rates), use of milrinone (for lusitropic effect in LV with abnormal relaxation), and use of norepinephrine as alpha-agonist. As always, it is important to treat acidosis and hyperglycemia appropriately.)

- See selected references in the Reference Section (19).

In summary, several challenges related to beating heart surgery need to be recognized:

- Proper patient selection
- The need to create a quiet and relatively still operative field
- The potential for, and management of, rapid hemodynamic change related to manipulation of the heart
- The potential for cardiac ischemia during the procedure
- The possibility of the need to rapidly convert to on-pump CABG
- The potential for "ultra-fast tracking" and cost savings
Anesthetic Concerns

The following is a suggested protocol from pertinent articles in the current literature. Ultimately the choice of medications is left up to the staff anesthesiologist.

Monitors

- Monitors are the same as CABG requiring CPB
- TEE is useful to monitor for regional wall abnormalities, the new onset of valvular regurgitation, and LV and/or RV volume status
- TEE images may be difficult to obtain and uninformative during extreme retraction of the heart

General Induction

- Consider a single dose of subarachnoid opioid
- Midazolam, thiopental, propofol or etomidate
- Vecuronium 0.1 mg/kg, (follow twitches)
- Fentanyl 5-10 µg/kg or sufentanil 0.25 µg/kg
- Continuous inhaled anesthetics with air/oxygen OR propofol 100-180 mcg/kg/min
- Depending on approach, a double lumen tube may be required for better surgical exposure (discuss with surgeon)

Heparinization

- NOTE: antifibrinolytics (AMICAR, tranexamic acid) are usually NOT given
- Maintain an ACT greater than 250 seconds with 100-200 units/kg of heparin but some institutions uses full heparinization (3-400 units/kg) to maintain the ACT > 400 seconds
Because the patient is normothermic, the ACT will continually decline as heparin is metabolized. Check the ACT every 30 minutes and re-dose the heparin as needed to maintain the desired ACT, or consider a heparin infusion.

Maintain Normothermia

- Warm the IV fluids
- Use forced-air warming when appropriate
- Warm the operating room

Maintaining Hemodynamic Stability

- (Remind the surgeon to use gradual or slow displacement of the heart)
- Trendelenburg position (to maintain volume)
- Table rotation – minimizes the required cardiac manipulation and aids in lateral wall exposure
- Vasopressors (and/or inotropic medications) – Use vasopressors to increase the mean arterial pressure and collateral circulation prior to cardiac retraction
- Nitrates – use of low dose nitroglycerin may prevent/treat vasospasm
- Shunting - The surgeon may routinely or selectively place an intracoronary shunt to decrease bleeding and provide distal flow.
- Pacing – The patient may become severely bradycardic with positioning so equipment for temporary epicardial pacing should be available.

Operative Conditions

Some notes on providing optimum operative conditions.

- Exposure is largely determined by the surgical approach and the ability of the surgeon to perform (and the patient to tolerate) cardiac manipulation
- Lung isolation techniques (double lumen ETT or Univent, bronchial blocker, OLV) may be needed for thoracotomy or "mini-thoracotomy"
- More lifting, and hence hemodynamic compromise and/or myocardial ischemia, will result during exposure for grafting to the RCA or posterior diagonal branches and especially the circumflex or obtuse marginal branches
- Heart rate control: The need for pharmacological control has lessened with the advent of better vessel isolating techniques. In fact, now that a goal is to avoid hemodynamic compromise that can threaten myocardial perfusion, adequate heart rates (>60) should be sought which help sustain cardiac output and blood pressure. Patients with bradycardia may not have adequate cardiac output.

Conversion to Standard CABG with CPB

It may be necessary to abandon off-pump techniques and convert the operation to a standard "on-pump" CABG. Timing is important when making a decision to convert the operation. If grafting is almost
complete, then it may be possible to support the patient for a short while without going on bypass. On the other hand, if the grafting has just been started and hemodynamic instability is persistent and unresponsive to therapy (put the heart back down, Trendelenburg, volume resuscitation, vasopressor, inotropes), then conversion to CPB may be indicated. Indications for conversion:

- Persistent hypotension (MAP < 50 mm Hg) &/or unacceptable cardiac output
- Severe, unresponsive ischemia
- Arrhythmias
- Persistent SvO2 <60%
- Inaccessible (e.g. intramyocardial coronaries) targets, suboptimal surgical exposure/conditions, etc
- (Remember to give additional heparin if you have not given a full "pump dose" of heparin)

**Fast Tracking**

Selected patients undergoing OPCAB may be allowed to emerge from general anesthesia in the operating room, with extubation following appropriate return of arousal and airway reflexes. Extubation in the operating room may allow bypassing the intensive care unit or a shortened stay in the ICU, with morning and afternoon cases being cycled through the same ICU/recovery bed. Success in fast tracking patients after OPCAB will be higher if the following conditions are met:

- Relatively uncomplicated procedure
- Hemodynamically stable with minimal support after operation
- No ongoing ischemia
- Pain adequately controlled
- Adequate level of consciousness and respiratory effort
- Minimal bleeding
- Adequate support for extubated patient in recovery unit

Ultimately, whether patients are extubated after OPCAB will be guided by the clinical judgement of individual clinicians, and institutional culture. Before a decision is made to emerge and extubate a cardiac surgical patient in the operating room, one must ensure the institution is ready for it.