

# **Anaesthesia for Ruptured Abdominal Aortic Aneurysm**

## **Recommendations for Management**

### **Dr Peter McLoughlin**

---

## **Introduction**

Cases of ruptured abdominal aortic aneurysm are commonly reviewed by the Department's Anaesthetic Mortality Committee. As anaesthetists are confronted by these cases only occasionally, it is hard to develop the familiarity and facility that comes from doing a particular type of procedure regularly.

These recommendations have been created to make available to anaesthetists within the Department an approach to the management of ruptured abdominal aortic aneurysms that the reviewers feel provides a best practice technique. It is hoped that the insights gained by the review of these cases over many years can be shared with the anaesthetists who perform this work.

## **Pre Operating Theatre Phase**

### **1. In the Emergency Department**

- **Anaesthetists**

Ideally at least one anaesthetist should attend the Emergency Department to observe the initial management, to liaise with the team preparing the theatre, to ensure that appropriate blood products are arranged and to accompany the patient during the transfer to theatre.

- **Diagnosis**

The diagnosis is made clinically, but an urgent ultrasound examination should be performed if possible, provided it does not unduly delay the transfer to theatre.

- **Airway**

It is preferable not to intubate the patient in the Emergency Department. Intubation drugs depress sympathetic drive and positive pressure ventilation significantly impairs venous return.

- **To operate or not**

Prolonged haemorrhagic shock, advanced age, deep coma despite restoration of a peripheral pulse or severe co-morbidities may make surgery futile. The decision to operate or not is a surgical one.

If the decision is made to proceed, the theatre team making the preliminary preparations should be informed by telephone immediately and the patient should be transferred to theatre without delay.

- Blood product ordering

As soon as the decision to proceed has been made, the anaesthetist should phone the blood bank and order twelve units of packed red cells, twelve units of fresh frozen plasma and twelve units of platelets.

- Volume replacement

Volume replacement in the Emergency Department should be minimal. The aim is to maintain adequate cerebral and coronary perfusion. The mental state is the best guide to volume resuscitation. Transfuse only until the patient responds to command or until there is a palpable brachial, femoral or carotid pulse. Usually this occurs at a systolic blood pressure in the upper arm of 80 mmHg.

Initial volume replacement should be with packed red cells, usually group specific, occasionally universal donor O negative. Anaemia must not be allowed to occur as the maintenance of myocardial oxygen delivery is essential in this low flow state.

- The transfer

Once the decision to operate has been made, the patient should be transferred to the theatre without delay. The transport corridor should be secured. A person should be sent ahead to hold the lift in readiness.

Transfer equipment should include ECG monitoring, a portable defibrillator, an oxygen cylinder and mask as well a self inflating bag for manual ventilation. Non-invasive automated blood pressure monitoring and oximetry may be used but in the shut-down patient may not provide much useful information.

## 2. Theatre Preparation

- Staff

Adequate staff numbers are essential and extra staff may need to be called in. The anaesthetic team should have at least five members. There should be a minimum of two anaesthetists preferably three and two experienced technicians. At least one anaesthetist must be senior. Where there are only two anaesthetists, the fifth person could be an anaesthetic resident or another technician.

- Cell salvage

Cell salvage can be useful in major haemorrhage associated with ruptured aneurysms but is also very time consuming from a staff resource point of view. One technician is fully occupied with this machine alone.

Because of the time consuming nature of cell saver operation, the mortality committee is divided on the place of cell saving in these life-threatening cases. One point of view holds that the cell saver can only be used with three technicians available (ie one for the cell saver and two for other tasks), while others are prepared to run the machine with two technicians in total.

- Additional equipment to be prepared prior to the arrival of the patient
  - Level One Infuser: Primed with normal saline.
  - Transducers x 2: For arterial and central venous pressure monitoring.
  - Disposables for an arterial line.
  - Disposables for a central venous line with at least three lumens.
  - A Swan Ganz introducer for large volume infusion.
  - Syringe pumps x 2: For adrenaline and GTN infusions.
  - Forced air warmer and temperature probe.
  - Urinary catheter if not already placed in the Emergency Department.
  
- Drugs
  - Ketamine
  - Suxamethonium
  - Non-depolarising relaxant
  - Adrenaline (1mg diluted in saline to 10 mL for bolus dosing)
  - Adrenaline (3mg diluted in saline to 50 mL for infusion)
  - GTN (50mg in 50 mL for infusion)
  - Antibiotics

## Theatre Phase

### 1. Roles

- The most senior anaesthetist must take explicit control and direct all activities.
  
- Technician #1 should be directed to run the Level One Infuser. This technician should:
  - Ensure the device is properly primed.
  - Assist with connection of the device to best available line on the patient on arrival in the theatre.
  - Assist with the transfer of the device to the definitive line when this has been inserted.
  - Operate the device under the senior anaesthetist's direction.
  - Report any slowing of the device's flow rate.
  - Prime and insert a replacement infusion set should this become necessary.
  - Take physical possession of all arriving blood products intended to be given via the infuser (red cell packs and FFP).
  - Under a medical practitioner's supervision, check all blood products intended for the infuser.
  - Attach used blood product stickers to appropriate chart.
  - Save all empty infusion packs in one convenient place for latter tallying. This is usually on a small drape on the floor against a wall.
  
- Technician #2 should:
  - Assist with normal induction tasks, including placement of lines, attachment of monitoring and airway management.
  - Physically run between the theatre and the blood bank to ferry blood products to the theatre. The shute is too inefficient in these cases.

- Process arterial blood gas analyses which should be performed every 20 minutes whilst any degree of haemorrhagic shock persists.
- Send other blood tests to the laboratory as described below.
- Other anaesthetists do not have defined roles but assist as directed by the senior anaesthetist.

## 2. Lines

- A large volume line is essential. A 14G cannula in the antecubital fossa inserted in the Emergency Department is satisfactory for initial management but a Swan Ganz introducer should be inserted into an internal jugular vein as an early priority and the Level One infuser switched from the antecubital cannula.
- A tri- or quad- lumen central line should be inserted as an early priority.
- An arterial line should be inserted as soon as possible. In practice this may not be until after the aorta is cross clamped and a reasonable blood pressure returns. In the interim, manual or automated indirect blood pressure should be used. Where no peripheral pulse can be detected it is reasonable to assume that the blood pressure is very low.

## 3. Infusions

- Adrenaline and GTN infusions should be attached to the central line as soon as it is inserted.

## 4. Induction to cross clamp

- Preoxygenation should begin as soon as the patient is transferred onto the operating table. Suction is placed under the pillow.
- The surgeons must be scrubbed and ready to operate and the abdomen must be prepped and draped before any induction drugs are given.
- Bolus adrenaline must be to hand before any induction drugs are given.
- Cricoid pressure is applied.
- If the patient is in any way conscious, ketamine (1-2 mg/kg) is the preferred induction agent followed by suxamethonium 1.5 mg/kg and rapid intubation. If the patient is comatose and unresponsive to painful stimuli, the induction agent may be omitted.
- Fentanyl should be given in minimal doses or avoided altogether as it is a potent sympatholytic. Although it is used with good effect in patients with cardiac disease, such patients are euvolaemic or even hypervolaemic. In severe haemorrhagic shock, maximum sympathetic drive is essential for survival and must be maintained.
- Ketamine raises blood pressure and heart rate by sympathetic stimulation. In these cases where sympathetic tone is already maximal, the direct depressant effects of ketamine may be seen. Loss of vigorous spontaneous ventilation aiding venous return also contributes to further decompensation at induction. The loss of a palpable peripheral pulse at induction should be anticipated and treated empirically with 100-200 microgram boluses of adrenaline until a pulse returns.

- As soon as the correct placement of the endotracheal tube is confirmed, the surgeons should be told to start operating.
- A long acting muscle relaxant should be given without waiting for the suxamethonium to wear off. Excellent relaxation is required as the surgeons attempt to place the cross clamp.
- Ventilation should be with 100% oxygen initially. While the surgeons are working high under the diaphragm to place the cross clamp, ventilation should be high-frequency, low-volume. As compliance may be difficult to predict, manual control of ventilation may be preferred at this time.
- The need for a volatile agent should be considered in light of the haemodynamic state. Ketamine 1mg/kg may be given every twenty minutes if there are concerns about wakefulness.
- Positive capnography confirms the presence of a central circulation in the absence of a peripheral pulse. However, the absence of a peripheral pulse should be treated with repeated adrenaline boluses.

## 5. Fluid management

- As soon as the clamp is on, massive volume resuscitation should begin with the Level One Infuser run at maximum flow rates.
- To prevent coagulopathy, red cell concentrates and FFP should be given in a ratio of 1:1. This ratio may need to be varied according to the most recent haemoglobin result.
- Anaemia accelerates the development of cardiogenic shock (superimposed on the haemorrhagic shock) and **must not be allowed to occur**. The haemoglobin should be maintained above 100 g/L.
- Crystalloids and colloids should be avoided as they favour the development of a dilutional coagulopathy.
- Large quantities of blood products need to be ordered well in advance. Aortic cross clamping usually allows return of a blood pressure but rarely stops the need for massive transfusion. Ongoing heavy blood loss from lumbar segmental arteries is common and is technically difficult for surgeons to control. It is the responsibility of the **senior anaesthetist** to keep track of what blood products have been ordered, what is in transit and what more needs to be ordered to maintain the supply to the Level One infuser. Blood products must never be allowed to run out.
- If the supply of FFP does fail to keep pace with demand, normal saline may be the preferred crystalloid as the lactate in Hartmann's will not readily be metabolised and will make interpretation of the blood lactate level difficult. Also, the calcium in Hartmann's is not compatible with citrated blood products. Calcium is better given as a separate injection through a different line. Where a colloid is preferred, Gelofusin may be better than Haemaccel in respect to the calcium issues.

## 6. Blood testing

- Regular arterial blood gases must be started as soon as an arterial line is placed. They should be performed every twenty minutes until the patient is no longer clinically shocked. This task must be given a very high priority and will consume a large part of the time of technician #2.
- Regular full blood counts and coagulation testing should be sent hourly.
- Blood gas and electrolyte management
  - Hypocalcaemia. Massive transfusion with a 1:1 ratio of FFP and red cell concentrates will deliver massive amounts of citrate. Ionised calcium will fall precipitously and **must be checked** on each arterial blood gas sample. Hypocalcaemia substantially reduces contractility and induces cardiogenic shock. Calcium chloride 1 gram (10ml 10% CaCl<sub>2</sub>) should be given to keep the ionised calcium in the normal range (>1.0 mmol/L). This may be required frequently while transfusion rates are high.
  - Acidosis does not always require treatment. In the absence of coronary artery disease, cardiac failure does not occur with severe acidosis provided calcium, haemoglobin and coronary perfusion pressures are maintained in the normal range. Alkali treatment should be considered when despite correction of hypocalcaemia and anaemia, hypotension remains unresponsive to adrenaline and central venous pressure is rising. When acidosis is treated, consideration should be given to using THAM. One 0.3M 500mL bottle has a similar effect on pH as does 100 mmol of sodium bicarbonate. Its main advantage is that it reduces PaCO<sub>2</sub>. It also lowers blood glucose levels.
  - Hyperkalaemia may sometimes be seen with massive transfusion. It should be treated with insulin. Dextrose should not be given if the blood glucose is already high.
  - Hyperglycaemia is common. Levels above 15 mmol/L are usually treated. Additional potassium may occasionally be needed.
- Coagulopathy
  - The patient should be kept warm. Hypothermia impairs both platelet function and clotting times.
  - Platelets should be given to maintain platelet counts above 100,000.
  - Transfusing FFP for volume replacement (avoiding crystalloids and colloids entirely) significantly protects against dilutional coagulopathy and offsets consumption coagulopathy. Fibrinogen may still fall and levels should be checked on coagulation tests. Cryoprecipitate should be given to maintain the fibrinogen level greater than 2g/L.
  - Abnormal bleeding despite normalising coagulation profiles and platelet counts warrants D-dimer testing. Empirical aprotinin treatment should be considered. The initial dose is one million units.
- Haemodynamic management
  - Until the clamp is applied, blood pressure consistent with a palpable pulse (60-80 mmHg systolic) is all that is required.

- Once the clamp is applied, systolic blood pressure must be maintained above 100 mmHg systolic to sustain adequate coronary perfusion pressure. If rapid volume replacement and calcium supplementation alone cannot achieve this pressure, supplemental adrenaline infusion and boluses must be used.
- A rising central venous pressure may indicate a failing heart. Don't assume that volume replacement can lessen. Check the causes (anaemia, hypocalcaemia, hypotension) and treat. Support the heart if necessary with adrenaline. A rising central venous pressure should only be taken as indicating returning normovolaemia when there is clinical evidence of improving peripheral perfusion.
- When haemostasis is substantially achieved and central blood volume is returning to normal and central venous pressure is rising, a GTN infusion (1 mg/mL) should be run (i) to facilitate opening up of shut down peripheral tissues and (ii) to expand the blood volume. When the clamp is released and the lower limbs are reperfused, the GTN infusion can be reduced or switched off to assist in maintaining the systolic pressure.
  
- Renal function
  - Diuretics should be avoided until all bleeding has been definitively stopped and hypovolaemia corrected. They should only be considered once the clamp is off and urine output remains low despite a good blood pressure, high central venous pressure and good peripheral perfusion.
  
- Temperature
  - Temperature must be measured. Nasopharyngeal or bladder temperatures are both acceptable. Bair Huggers are recommended. All fluids must be warmed. Ideally all would go through the Level One Infuser.
  
- Miscellaneous
  - Antibiotic prophylaxis must not be forgotten. A nasogastric tube should be inserted at some convenient time, but not at induction.

---

## **Anaesthesia for Ruptured Abdominal Aortic Aneurysm Recommendations for Management**

**Prepared by Peter McLoughlin  
Chair  
Anaesthetic Mortality Committee  
Department of Anaesthesia & Pain Medicine  
Royal Perth Hospital**

**Version 1.0 (3<sup>rd</sup> December 2002)**