GUIDELINES FOR MANAGEMENT OF
SPINE PATIENTS AND USE OF POLYMETHYL METHACRYLATE (PMMA) AND FOR SUSPECTED ACUTE PULMONARY EMBOLUS

For questions related to these guidelines, please contact Drs. Michael Souter, Kris Natrajan, or Lorri Lee.

A. USE OF POLYMETHYL METHACRYLATE or OTHER CEMENT FOR INJECTION INTO VERTEBRAL BODY

Extravasation of cement from the vertebral body with resultant pulmonary embolus is a well known complication of injection of cement into vertebral bodies, and may result in hemodynamic collapse.1-4 These guidelines are intended to optimize care of spine patients who receive vertebral body cement injections in the event of a pulmonary embolus.

1. Spine surgeons will list “cement injection” on the surgery schedule if patient is to be injected with polymethylmethacrylate or other cement and will inform the attending anesthesiologist for the case prior to surgery re: what type of cement is to be injected. (Cement containing calcium phosphate has been associated with high mortality when embolized.)

2. A bed / gurney should be readily available outside the operating room with a sign stating “DO NOT MOVE-SPINE SURGERY PATIENT” in the event that the patient requires sudden turning supine during surgery.

3. Except for patients having isolated vertebroplasty or kyphoplasty procedures, the anesthesiologist should consider:
   a. Placing a cordis and arterial line in patients receiving PMMA or other cement during spine surgery so that ready access for a PA catheter is available in the event of a pulmonary embolus (and placing an arterial line for isolated vertebroplasty or kyphoplasty patients).
   b. using perioperative cardiac output monitoring (e.g. LiDCO, ECOM endotracheal tube)
   c. Identifying a transesophageal echo (TEE) machine and staff available for using the TEE for these cases.
   d. Having a pulmonary catheter readily available in the room (unopened) in the event of a pulmonary embolus to monitor PA pressures and cardiac output.
   e. Having one or more of the pulmonary vasodilators / inotropes readily available in the room in the event of a suspected pulmonary embolus with hemodynamic collapse: milrinone, nitric oxide, isoproteronol, prostacyclin, and / or norepinephrine.

4. The surgeons will alert the attending anesthesiologist approximately 15 minutes prior to injection of the PMMA or other cement.
B. MANAGEMENT OF SUSPECTED PULMONARY EMBOLUS DURING SPINE SURGERY

Pulmonary emboli during spine surgery can occur from various sources: 1) air, 2) fat / bone marrow, and 3) artificial cement injections for augmenting vertebral bodies. One TEE study documented “80% of instrumented cases have moderate to high grade emboli, particularly during pedicle screw insertion.5

The circulatory collapse from pulmonary emboli is partially caused by pulmonary vasoconstriction and right heart failure, and can be ameliorated in animal studies with the use of pulmonary vasodilators/afterload reduction and inotropes.6-8 Hypoxemia is caused by ventilation-perfusion heterogeneity with an increase in blood flow to low ventilation-perfusion units, as emboli preferentially distribute to regions of higher pulmonary blood flow (which are also well-ventilated).9,10 Current treatment for hypoxemia is institution of high levels of positive end-expiratory pressure (PEEP).

1. If there is high suspicion for a pulmonary embolus by sudden significant decreases in oxygenation, blood pressure, and / or end tidal carbon dioxide with instability, the anesthesiologist should consider the following interventions:
   
a. Increase inspired O₂ concentration to 100%; support blood pressure with vasoactive drugs; and turn the patient supine immediately. Ensure hemodynamic stability off support for one hour prior to resuming surgery (see below, Section C).
   
b. If an air embolus is suspected, aspiration of air from a right atrial catheter may be attempted, but is frequently unsuccessful, particularly in the prone position in animal studies.11,12 Prevention of further air entrainment may be preventable by flooding the surgical field, and ensuring the surgical field is lower than the right atrium when possible. These maneuvers should not delay turning of the patient supine for further stabilization, and can be performed as the bed / gurney is brought into the OR.
   
c. Inserting a PA catheter to guide management of PA pressures and cardiac output
   
d. Inserting a TEE probe to evaluate for pulmonary emboli, right heart contractility, and filling volumes (caution if patient has elevated INR; contraindicated with significant esophageal strictures)
   
e. Consider administration of the following medications:
      
1) if MAP is >80 mm Hg, milrinone 50 ucg / kg bolus followed by an infusion at 0.5 ucg/kg/min (MAP may be increased by use of vasopressin or norepinephrine bolus). If milrinone causes significant hypotension, may add norepinephrine infusion.
   
2) Nitric oxide if available – start at 40ppm and may increase to 80ppm (higher doses may result in methemoglobinemia)
   
3) Isoproteronol infusion at 0.01 to 0.1 ucg / kg / min (no bolus) – may cause tachycardia and hypotension.

Written by: L. Lee, MD, Aug 2009
Approved by: Karen Dommino, MD, Sept 2009
4) **Prostacyclin** infusion at 5 – 15 nanograms / kg / min (no bolus) – may inhibit platelet function.

5) If PA pressures remain elevated despite above interventions, consider crushing **sildenafil** (1 mg / kg) and place down NG tube.

f. For hypoxemia, turn inspired O₂ concentration to 100% and consider use of **PEEP**

---

**C. MANAGEMENT IF THE PATIENT HAS BEEN TURNED SUPINE FOR RESUSCITATION**

In most circumstances, further surgery should not be attempted and the patient should be transferred to the care of an ICU team for investigation and management, once stable enough for transfer.

In some occasional instances, the patient’s condition may rapidly return to normal and the possibility of continuing with surgery may be considered, with a requirement for detailed discussion between anesthesia and surgery teams. Either team may declare surgery should not proceed.

In the situation where the decision is to proceed,

1. Stable cardiac output and blood pressure should be documented without the use of significant vasopressor dosages.

2. Blood gases within the normal range should be demonstrated.

3. Cardiac enzymes, serum electrolytes and a 12 lead ECG should have been checked and evaluated.

4. Hematology and coagulation studies should be within normal values and blood and FFP should be available

5. Cardiac output monitoring will be used for further management of the case.
REFERENCES


