How to do a PET/CT Scan and Not Glow in the Dark

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Goals:

After completion of the PBLD, participants will be able to discuss the anesthetic approach for combined PET/CT scans in terms of:

1. Preoperative evaluation and preparation.
2. Optimizing induction and maintenance of sedation/anesthesia.
3. Reducing the risk of aspiration.

Case:

It is your first time in PET scan but your department has a detailed protocol. Your patient is a 6-year old boy with newly diagnosed Non-Hodgkin’s lymphoma scheduled for a staging combined PET/CT scan. His past medical history is positive for asthma and procedural (needle) anxiety. Asthma history is positive for albuterol inhaler daily but negative for hospital and ICU admissions. His last wheezing episode was one week ago. He has no difficulty laying flat on his back, but he does snore occasionally.

What is a PET scan? What is a combined PET/CT scan? What challenges do these procedures specifically pose for pediatric anesthesiologists? What other history would you want to know about this patient’s prior to induction of anesthesia? Do you want any additional preoperative tests prior to proceeding with the PET/CT scan?

Your Hospital Detailed PET Scan Protocol

1) Blood Glucose level - 1 hr pre-FDG
2) IV fluids - 1 hr pre-FDG
3) Active warming - 1 hr pre-FDG
4) IV Fluids – 1 hr pre-scan
5) Active Warming - 1 hr pre-scan
6) PO/NG Oral contrast (if needed) - 1 hr pre-scan

Why is a glucose level needed? What is FDG? What are the risks of exposure to FDG? Would wearing a lead apron help decrease you exposure risk? What is active warming and why is it performed?
Oral contrast is needed for this study. It should be given one hour prior to the scan for the best possible CT image results. Your institution uses Omnipaque as its agent of choice.

*What are the risks associated with oral contrast administration? Is there a difference in the choice of oral contrast agent used? What effect does oral contrast administration have on gastric fluid volume?*

His mother is concerned because her son always “decompensates” when he sees needles and she does not think he will cooperate with drinking the contrast. For the diagnostic CT scan from one month ago he had an inhalation induction. (That study showed enlarged cervical lymph nodes without mediastinal involvement.)

*How will you manage this patient's blood draw, IV placement, induction, airway and maintenance of anesthesia? How will you minimize his risk for aspiration of oral contrast? How will you minimize your exposure to radiation?*

The patient is premedicated with midazolam 0.5 mg/kg PO. Fifteen minutes later, a 22-G IV is placed in the right hand, and a blood sample for glucose level is drawn and sent to the lab. The patient is taken to the warmed uptake room with his mother and given IV fluids over the next hour while being monitored with continuous pulse oximetry.

*How will you get the patient to drink the oral contrast? Will you allow the mother to stay with her son in the uptake room after he has received the FDG injection?*

The patient is then given 80 mL of oral contrast mixed with some clear sugar-free grape juice along with the FDG injection. His mother stays with him because she is worried he will get anxious if she leaves him alone in the uptake room. After an hour of FDG uptake, the child is positioned onto the PET/CT scanner table with standard monitoring.

*How would you proceed with the induction and maintenance of anesthesia? Does it make a difference that Omnipaque is a clear liquid? If oral contrast had not been indicated, how would you induce this patient? What if the oral contrast administration had been completed over 2 hours prior to induction? Does the history of asthma influence your decision?*

You decide to sedate this patient for the PET/CT scan. You place him on 2 L nasal cannula and give him a 1 mg/kg bolus of Propofol. You begin the Propofol infusion at a rate of 220 mcg/kg/min. As the nurse is placing the foley catheter, the patient starts to cough. You give him another 1 mg/kg bolus of Propofol, but he continues to move around.

*What would you do next to ensure that the patient lays still? Would you place an LMA in this patient or an ETT?*

You have decided to perform a rapid-sequence induction with cricoid pressure followed by endotracheal intubation. You use sevoflurane for your maintenance anesthetic along with 1 mg/kg of fentanyl. About 30 minutes into the scan, you notice that the EtCO2 tracing has
disappeared. You ask the radiologist to stop the PET scan so you can troubleshoot what is going on. As you try to manually ventilate the patient, you notice that you require high peak inspiratory pressures and the oxygen saturation is only 92%.

**What is your differential diagnosis? How would you treat each of these potential complications?**

You suspect that the patient might have aspirated some of the oral contrast agent. You suction the stomach out and get about 50 mL of purple-tinged gastric contents. The oxygen saturation remains at 92%.

**Would you proceed with the planned PET/CT? Would you extubate this patient?**

You increase the FiO2 to 100% and proceed with the remainder of the PET/CT scan. At the end of the case, the patient is extubated after he is awake and spontaneously breathing. As you are putting the oxygen tank under the patient’s stretcher, the patient starts thrashing around and rips out his IV. He then proceeds to pull out his foley catheter and urine sprays all over the scanner table and the nurse.

**What do you do now? Which bodily fluid is more radioactive, blood or urine? How should the urine/foley be properly disposed of? What should you make sure to do when replacing the IV? What precautions should people with direct contact of this patient take?**

**Discussion:**

Positron emission tomography (PET) is a nuclear medicine imaging modality that produces a 3-dimensional image of functional processes in the body using a positron-emitting radionuclide tracer. PET scans are useful for the distinction between benign and malignant disease processes, staging of the cancer, and follow up for response to therapy. Since PET imaging is most useful in combination with anatomical imaging, the latest PET scan machines are now available with integrated high-end CT scanners. Because the two scans can be performed in immediate sequence during the same session, the two sets of images are more precisely registered, so that areas of abnormality on the PET imaging can be more accurately correlated with the anatomy on CT images.

Fludeoxyglucose (FDG), a glucose analog, is a positron-emitting radioactive isotope most commonly used for PET scans, and it is administered by intravenous injection. In cancer, the cells are generally characterized by enhanced glucose metabolism. These cancer cells in the body take up the FDG, and FDG that is not involved in glucose metabolism in any tissue is eliminated from the body unchanged in the urine. To minimize radiation-absorbed dose to the bladder, adequate hydration is encouraged to allow for frequent voiding during the first hour after intravenous injection of FDG. Occasionally, a foley catheter is placed if a patient cannot void prior to the PET/CT or if a pelvic study is involved.
Hyperglycemia can result in poor uptake of FDG into tissues as the elevated blood glucose competes with FDG for transport into cells. This is why it is imperative to make sure the patient is not on TPN or has not had and sugar-containing beverages at least 4-8 hours prior to the injection. After injection, children should avoid excessive movement or talking. They should be kept warm during the uptake phase with an adequately heated room and the use of warm blankets. This approach may help reduce radiotracer uptake in thermogenic brown fat.

The radiation exposure from FDG results in internal exposure to the patient and low-level external exposure to the other people in their vicinity. Following simple guidelines for reducing contact time and increasing distance is the best practice to minimize radiation exposure to staff. For patients with urinary catheters, standard precautions for dealing with biohazardous material are recommended to prevent undue radiation exposure and contamination. The half-life of FDG is 110 minutes; 18-24 hours after injection, it is expected that the FDG is completely metabolized or eliminated from the body. Animal reproduction studies have not been conducted with FDG, but it is recommended that known pregnant staff members avoid taking care of patients undergoing PET scan.

Barium sulfate preparations are typically the contrast agent of choice in CT imaging of the gastrointestinal tract. But in children who require sedation or general anesthesia, this type of contrast creates a greater risk. Barium sulfate is a high-osmolar, water insoluble powder that is mixed with water to form an opaque white mixture. A larger volume of pre-mixed volume is required, and it can cause chemical pneumonitis if aspirated by the patient. Patients usually complain about the taste, and it can cause nausea, vomiting, and diarrhea. There are newer contrast agents that are water soluble, low-osmolar clear liquids such as Iohexol (Omnipaque). The volume needed to achieve desired results is much less than barium sulfate preparations and it is much more well-tolerated by patients as it is tasteless. Iohexol is fairly low-risk if aspirated.

Combined PET/CT scans in young children pose unique challenges to the anesthesiologist. These studies require active patient warming and intravenous FDG, a high gamma radiation marker, one to two hours prior to the scans. Timing of induction must balance the advantages of anesthesia for the child and radiation exposure to healthcare professionals. Approaches to decrease aspiration risk when oral contrast is needed must also be considered; the advantages of deep sedation versus general anesthesia must be weighed. Pediatric anesthesiologists need to be familiar with the variables of combined PET/CT scans and anesthetic techniques that can minimize radiation exposure while providing safe and effective patient care.
References:


