

PBLD – Table # 13

We're doing WHAT!? Patient-oriented care for a Sitting followed by an Awake Craniotomy in a 12 year old

Moderators: Jennifer L. Hernandez, M.D., Children's Medical Center, Dallas, TX
Justin L. Lockman, M.D., The Children's Hospital of Philadelphia, Philadelphia, PA

Objectives:

- Review of indications, preparation, and intraoperative management for craniotomy in the sitting position.
- Discussion of risk factors, monitoring options, and treatment for venous air embolism and other neurosurgical complications.
- Review of indications, preparation, and intraoperative management for craniotomy in the awake pediatric patient.
- Discussion of non-pharmacologic and pharmacologic management strategies for perioperative anxiety in the pediatric patient undergoing "awake surgery".
- Communication and team dynamics: A review of effective strategies for communicating with multidisciplinary professionals during complex and high-risk cases.

Case history:

A 12-year-old girl with intractable epilepsy is found to have a left (dominant) temporal lobe mass. Its location is deep to Wernicke's language area, and in the interest of speech preservation, the surgical team decides to perform an occipital craniotomy in the sitting position with attempted supracerebellar endoscopic resection.

Questions:

What is the definition of medically refractory epilepsy? What special considerations are involved in the preoperative evaluation of patients for epilepsy surgery?

What are the effects of antiepileptic medications (AEDs) on the pharmacology of anesthetic medications? What are the effects of anesthetic agents on the seizure threshold?

What are the unique potential risks/problems associated with this surgical approach? What measures can be taken to minimize these risks? What are the important positioning considerations for occipital (infratentorial) endoscopic surgery?

Preoperative physical examination:

Your examination reveals an anxious, yet cooperative 49 Kg female. She is right-hand dominant, of normal intelligence, and English speaking. Preoperative vital signs are unremarkable and she is neurologically intact. She admits that she is terribly afraid of needles.

Questions:

Would you consider a sedative premedication? What is your anesthetic plan? Are there any special monitors or medications necessary for this procedure (aside from standard ASA monitors)? What intravascular lines do you plan to place and why?

Case progression:

Anesthesia induction, intubation, and line placement occur without consequence. Slight hypotension occurs with transition to the sitting position, but recovers with a fluid bolus. No sympathetic response occurs with incision or bone flap removal. Approximately three hours into the case, the surgeons complain of “tightness” and poor visualization in the surgical field and request more brain relaxation.

Questions:

What anesthetic management techniques can be employed to optimize the surgical field and promote more “brain relaxation?”

Case progression:

The surgical conditions improve with the adjustments you have made. Approximately one hour later, the patient's end-tidal carbon dioxide acutely drops from 37 to 18 mm Hg. In rapid succession, she begins to desaturate and becomes hypotensive. A millwheel murmur is noticed via precordial Doppler ultrasound.

Questions:

What is the differential diagnosis for a sudden drop in end-tidal carbon dioxide concentration? What actions should you take to immediately stabilize the patient? What is the most sensitive way to detect venous air embolism?

Case progression:

The patient is stabilized, but the case is aborted due to difficulty with the endoscopic surgical approach. The patient is taken directly for urgent brain CT and then to the PICU for extubation and recovery. She is re-scheduled four weeks later for an open left temporal craniotomy with cortex resection. In order to avoid potential damage to eloquent cortical areas, the team has this time elected to utilize intraoperative awake brain mapping and speech/neurocognitive monitoring.

Questions:

What are the indications for awake craniotomy? How does one determine suitability for awake craniotomy in the pediatric population? What are the stages of the surgical procedure and the related anesthetic goals? What anesthetic options are available for meeting these goals? Identify the specific challenges associated with asleep-awake-asleep techniques. What are the potential complications?

Case progression:

Upon arrival to the OR, you perform a mask induction with a sevoflurane/nitrous oxide mixture in order to facilitate IV and arterial line placement. Once intravascular access is established, oxygen is administered via nasal cannula equipped with a carbon dioxide sampling line. You begin propofol, dexmedetomidine, and remifentanyl infusions. You also perform a scalp block to facilitate head fixation in a Mayfield frame.

Questions:

What specific nerves do you target when performing a scalp nerve block? What are your anatomic landmarks? Which local anesthetic do you choose and why? Is it preferable to utilize an epinephrine containing local anesthetic? Why or why not?

Case progression:

Skin incision, bone flap removal and dural dissection are uneventful. You discontinue the propofol and remifentanyl infusions to allow for functional cortical mapping and neurocognitive testing; you continue dexmedetomidine at a low-dose. The patient is awake and cooperative in a short period of time. After a period of testing, the surgeon determines the need for greater surgical exposure, necessitating a small extension of the bone flap. He proceeds with the exposure, resulting in an acute increase in the patient's pain, anxiety and agitation. You are unable to console her and she begins forcibly moving her body in an attempt to escape the stimulus. The surgeon becomes angry, accuses you of not paying attention, and instructs you to immediately stop the patient from moving.

Questions:

What do you do? Given that her head is still fixated, what are the potential complications associated with this scenario? How do you balance the need for ongoing neuropsychological testing and with the risk of apnea associated with a rapid bolus of sedative in this potentially dangerous situation? How could communication between the surgeon, neuropsychologist, and you have been improved in order to avoid this situation? Describe closed-loop communication and a shared mental model.

Case progression:

You administer small boluses of fentanyl and propofol. There is marked improvement in her level of anxiety, but her respiratory rate decreases to 4 breaths per minute and her oxygen saturation drops to 90%. You immediately increase the oxygen flow rate and perform a jaw thrust maneuver in order to stimulate her respiratory drive.

Questions:

What would you do if apnea or airway obstruction become problematic in this situation? If you had to intubate the patient, how would you do it?

Case progression:

Her respiratory rate and oxygen saturation improve with your intervention. Blood gas analysis confirms normal ventilation. Dexmedetomidine infusion is maintained at 0.2 mcg/kg/hr for the remainder of the cortical mapping and tumor resection. Once completed, the propofol and remifentanyl infusions are restarted for wound closure. Propofol and dexmedetomidine are discontinued during skin closure, and remifentanyl is continued. Scalp block is repeated after skin closure, and the patient awakens shortly after discontinuation of remifentanyl. At the conclusion of the case, the patient is brought to the ICU awake, comfortable, and calm with no apparent complications.



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Discussion:

Slow-growing, low-grade gliomas are among the most common causes of seizures in children referred for surgical treatment.¹ Indications for epilepsy surgery include intractable seizures over a period of 18 to 24 months despite combination therapy with at least two antiepileptic medications at maximally tolerated doses.² Those who exhibit satisfactory seizure control, yet significant adverse side effects from antiepileptic medications, may also be considered for surgical management. Epilepsy surgery can improve seizure control and quality of life, but resection of lesions adjacent to eloquent brain regions pose great challenge, particularly in pediatric patients.

Surgical candidates undergo an extensive evaluation process. Localization of seizure focus is accomplished by electroencephalography (EEG). Imaging modalities that have facilitated the mapping of epileptogenic foci with respect to eloquent cortical areas also include functional magnetic resonance imaging (fMRI), positron emission tomography (PET), and single photon emission-computed tomography.

In addition to a thorough history and physical, a complete neurologic examination should be performed as part of the preoperative assessment. Special attention should be given to the seizure history, level of consciousness, signs/symptoms of elevated intracranial pressure (ICP), preoperative neurologic deficits, and current medications. When planning an anesthetic, it is also important to consider the pharmacokinetic and pharmacodynamic effects of antiepileptic medications and how they may interact with anesthetic agents. Additionally, the sitting position itself merits further screening for musculoskeletal problems, peripheral nerve injuries, and cardiovascular problems that may make the patient vulnerable with respect to the positioning demands. Preoperative screening for a patent foramen ovale (PFO) has been proposed, but is not uniformly accepted. Alternative positioning may be warranted in the setting of a PFO due to the increased potential for paradoxical air embolism (PAE).

The sitting position in neurosurgery historically has been used for cases involving the posterior cranial fossa and posterior approaches to the cervical spine. More recently, with advances in minimally invasive endoscopic and neuronavigation techniques, the sitting position facilitates certain supracerebellar approaches to tumors located deep within the brain. Although minimally invasive craniotomies afford decreased approach-related iatrogenic trauma with the potential for reduced morbidity, these highly specialized techniques in conjunction with the sitting position pose unique challenges to the anesthesiologist.

The decreased dural sinus pressure associated with the head-up position increases the risk for air entrainment into the venous system through open venous channels. In order to prevent catastrophic complications, meticulous preparation in the prevention, detection and acute management of venous air embolism is warranted. Typically, two large bore venous cannulas and an arterial line for continuous blood pressure monitoring are sufficient for most craniotomies. However, pre-operative placement of a multiple-orifice central venous catheter carefully positioned in the superior vena cava-right atrial junction may allow for rapid aspiration of air and improved hemodynamic parameters in the setting of VAE. Patient age and size may prohibit its use in the pediatric population, thereby placing greater emphasis on the use of monitoring devices that are sensitive in VAE detection. Transesophageal echocardiography is currently the most sensitive and specific in VAE detection, but its use in this setting is limited because of its invasiveness, lack of availability, and expertise required for its use. In comparison, precordial doppler sonography is also highly sensitive and noninvasive, making a more suitable option in this setting. If available, end-tidal nitrogen detection is also sensitive for VAE.

A significant venous air embolism can manifest as bronchospasm, hypoxemia, hypercapnia, decreased ET_{CO_2} , hypotension, cardiac dysrhythmias and cardiovascular collapse, depending on the size of the embolus and the rate of entry of air into the veins.

Awake craniotomy for epilepsy surgery in the adult population is an established neurosurgical approach that allows for more optimal tumor resection from the dominant frontal lobe and reduced post-operative morbidity. The asleep-awake-asleep technique permits electrophysiological monitoring and intraoperative testing of speech, motor, and executive functioning. Although concerns regarding over sedation, lost airway, hemodynamic instability, and agitation are evident in both adult and pediatric patients, the latter group are considered by most

to be particularly challenging. Many are reluctant to consider this operative approach in children due to questions regarding their developmental maturity and anticipated level of cooperation.

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