Airway Management in the Neurosurgical Patient

NeuroAnesthesia Quiz # 64

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Question 1: Arnold Chiari Malformation

Question 2: Cervical spine disease

Question 3: Awake Craniotomy

Question 4: Carotid Endarterectomy

Question 5: Transphenoidal Pituitary Resection
Problems that merit concern regarding the airway in patients with Arnold Chiari Malformation (ACM) include all of the following Except:

A. Vocal cord paralysis
B. Central sleep apnea
C. Craniovertebral Junction instability
D. Syringomyelia in a parturient
In Chiari type II, which is typically noted at infancy and associated with myelomeningocele, both the brainstem and cerebellar tonsils herniate into the spinal canal blocking CSF flow causing hydrocephalus. The herniation of these posterior fossa contents leads to stretching and compression of the CN X (with paresis of the recurrent laryngeal nerve -RLN) causing bilateral vocal cord paralysis. These patients will often require tracheostomy.

Central sleep apnea (cessation of airflow due to absence of respiratory effort) occurs due to brainstem dysfunction and occurs mostly in patients with Arnold Chiari type II. Central sleep apnea alone requires attention to ensuring that the patient is able to safely resume control of his/her respirations after extubation. Close observation in the PACU is essential in this patient. Associated other symptoms like stridor from vocal cord paralysis which more directly affects the airway oftentimes necessitates a tracheostomy and/or a gastrostomy tube.


Zaremba S, Chamberlin N, Eikermann, Sleep Medicine Miller’s Anesthesia. 8th ed. 2015. Saunders, PA

ACM type | I | II | III | IV
---|---|---|---|---
Anatomy | Cerebellar tonsils protrude in spinal canal (5mm below foramen magnum) | Cerebellar Tonsils/vermis, 4th V. and lower brainstem in spinal canal | Cerebellum in spinal canal | Incomplete dev. Cerebellum

Associated w/ | Syrinx | Hydrocephalus Myelomeningocele | Encephalocele | Often fatal
A small subset of patients with Arnold Chiari malformation (ACM) will have evidence of craniovertebral junction (CVJ) instability and require cervical spine stabilization in addition to posterior fossa decompression. In a retrospective analysis of 1700 children presenting with CVJ abnormalities, the most common neurologic deficit reported was myelopathy. The diagnosis of CVJ instability is based on clinical and radiographic findings.

Minimizing neck motion during intubation of this unstable cervical spine is the goal. Awake FOI is used for most cases of CMI with CVJ instability.

In the pregnant patient with ACM and associated syringomyelia (formation of fluid (CSF) filled cavities within the spinal cord (syinx)), increased CSF pressure with valsalva during labor and delivery may exacerbate compression of the spinal cord. If general anesthesia for c-section is planned, avoiding neck extension during intubation to avoid additional cervical spinal cord compression is warranted.

While safe delivery (Cesarean section and vaginal delivery) under GA and neuraxial anesthesia occurred in a few small case series it is essential that imaging be available together with input from an interdisciplinary team of physicians.


All of the following are true regarding the cervical spine and airway management EXCEPT:

A. The most common cause for airway compromise after cervical spine surgery is airway edema

B. Airway manipulation can cause injury to the cervical spinal cord.

C. Use of LMA for airway management does not result in movement of the cervical spine

D. In a patient for cervical spine surgery presenting with Lhermitte’s sign, it is best to keep the head neutral during airway manipulation.
The most common cause for airway compromise after cervical spine surgery, particularly the anterior approach is edema of the laryngeal/pharyngeal and prevertebral soft tissue. Premature extubation of these patients may lead to the need for postoperative emergency airway management.

Risk factors associated with postoperative emergency airway management after cervical spine surgery include: surgical time>10 hrs., obesity, >4 units of blood transfused, and age >65 years.

According to the ASA closed claims, analysis of cervical cord, nerve root, and/or bony spine injuries (n=48) comprised 0.9% of all claims for general anesthesia (n=5231). The majority of these cases were reported in cervical spine surgeries. Airway management was the cause of neuronal injury in 11% of cases and most of these patients were intubated by DL and not Fiberoptic bronchoscopy. In 6 of these claims, cervical spine cord injury was attributed to airway management.

All of the airway devices available today can cause movement of the cervical spine increasing the risk of spinal cord injury.

- When comparing DL, LMA, and Fiberoptic intubation (FOI), FOI produced the least motion in the upper cervical spine.
- While glidescope produced better glottis visualization compared to DL with general anesthesia and neuromuscular relaxation, movement of non-pathologic C-spine was about the same.
- In a cadaver study with instability manufactured at C1-2, chin lift/jaw thrust caused more motion than either oral or nasal intubation.

Patients with myelopathy have spinal cord compression due to significant spinal stenosis. Lhermitte’s sign suggests compression of the spinal cord at the neck. This physical exam sign is elicited by flexion or extension of the neck. In response, the patient reports an electrical sensation that runs down the back and into the limbs.

An obese patient with OSA and depression presents for resection of a left frontal lobe mass with surrounding edema with awake intraoperative mapping. Fifteen minutes into awake mapping, the patient becomes increasingly anxious and appears to be straining against the headpins of the mayfield device and clenching her teeth. The intraoperative psychologist, surgeon and anesthesiology team are unable to redirect her with verbal reassurance and her anxiety is making it difficult for her to follow commands. What is the LEAST appropriate next course of action?

A. Check with the neurophysiologist to ensure no seizure activity

B. Continue brain stimulation and mapping while reattempting to verbally redirect the patient

C. Check oxygenation, ventilation, and consider GETA

D. Administer a bolus of dexmedetomidine and start an infusion

Contributed by CA-3 Yifan Xu, MD, Oregon Health Sciences University, Portland Oregon.
ECoG for monitoring seizures during AC is very helpful. Seizures during AC must be treated immediately by stopping brain stimulation and irrigating with cold irrigation to the brain. If continued seizure activity is noted, the patient should be treated with anti-epileptic drugs. For intractable seizures, AC is aborted and general anesthesia with endotracheal intubation is induced.

In a retrospective review, of 477 Awake Craniotomies, 12.6% had intraoperative seizures during mapping with an intraoperative AC failure rate of 2.3%.

Patient selection is an important aspect of performing an awake craniotomy. Patients like this (obese with OSA) as well as other patients with anxiety for example may not be candidates for this procedure. Continued mapping in this agitated patient immobilized in the Mayfield head-holder increases her risk for significant head injury. While avoiding additional sedatives in this patient at risk for excessive somnolence and upper airway obstruction due to her obesity and OSA maybe prudent in this case, continued verbal redirect is not working to calm the patient and promote mapping. Another approach is indicated in order to prevent patient harm.

Garavaglia M, Das S, et al. Anesthetic approach to high-risk patients and prolonged awake craniotomy using Dexmedetomidine and scalp block. JNA. 2013;00(0):1-8
Awake craniotomies are historically the “gold standard” for surgical resection of tumors in eloquent brain areas: compared to tumor resections under GETA, it allows greater mass resection, increasing survival time and preserves more function. However, in a patient who is not able to follow commands to gain benefit from awake mapping, the risks of continuing, i.e. injury, and/or oversedation and airway obstruction may outweigh the benefits of awake tumor resection. Assessment of oxygenation and ventilation are essential to rule out and treat hypoxemia and hypercarbia. If the patient is unable to tolerate awake mapping, abortion of awake craniotomy with induction of general anesthesia is a safe alternative and merits consideration.


Dexmedetomidine, a central and peripheral alpha-2 agonist has anxiolytic, sympatholytic, anti-emetic, and analgesic properties with minimal effect on respiratory dynamics. Multiple ICU studies have demonstrated its potential to be anti-deliriogenic, benzodiazepine-sparing, and opioid-sparing. Acting on the alpha-2 receptors of the locus ceruleus, it decreases noradrenergic neural activity and creates a “cooperative” sedation. It has become increasingly favored as a neuroanesthetic adjunct due to its ability to match cerebral metabolic rate reduction to a decrease of cerebral blood flow, preventing demand mismatch.

A bolus dose of 1 mcg/kg over 10 minutes will be slow enough to avoid alpha-1 induced hypertension while maintaining the patient’s respiratory drive and ability to follow commands (follow with a continuous infusion starting at 0.1mcg/kg/hr.). This may provide an alternative to conversion to GETA.

Approximately 20 minutes after you dropped your patient to the PACU awake and breathing comfortably after left CEA under general anesthesia, the nurse calls you because the patient has become increasingly SOB. What is the next step in the management of this patient?

A. Assure the patient that this feeling will improve
B. Emergently intubate your patient
C. Obtain an ABG
D. Examine the patient
It is critical that you go see the patient to be sure that the airway is not compromised.

If this patient had been administered a regional (deep cervical plexus block) for his CEA instead of general anesthesia, SOB from blockade of the phrenic nerve would help explain his symptoms. In this case, assurance after ruling out other complications of CEA would be appropriate.

Coughing and consequent hypertension during emergence after general anesthesia can contribute to bleeding and hematoma formation, compromising the airway. In a meta-analysis of studies examining medications for preventing this problem, Lidocaine, dexmedetomidine, remifentanyl, and fentanyl, were each better than placebo in preventing coughing on emergence with dexmedetomidine ranked most effective.

Herrick I, Arango MF, Gelb, Ischemic Cerebrovascular disease. In Handbook of Neuroanesthesia, Newfield and Cottrell, eds. 2007, Lippincott, PA

The incidence of postoperative wound hematoma after CEA has been reported to occur between 5.5-7% and is a risk factor for death after CEA. Most cases are due to venous oozing and external pressure may be adequate to treat. SOB after CEA is often related to neck hematoma expansion and mass effect on the trachea making intubation sometimes very difficult. In these cases, the patient’s symptoms may be best relieved by opening the wound followed by intubation and emergency reoperation. Next steps after examining the patient should include notifying the Neurosurgeon and an ENT surgeon while the anesthesiologist prepares for emergent intubation.

Herrick I, Arango MF, Gelb, Ischemic Cerebrovascular disease. In Handbook of Neuroanesthesia, Newfield and Cottrell, eds. 2007, Lippincott, PA

An arterial blood gas (ABG) provides valuable information regarding this patient’s respiratory status. Hypercapnia/respiratory acidosis, and/or hypoxemia which can be a problem in the PACU from residual sedation after general anesthesia or from unilateral denervation of the carotid body after CEA (impaired ventilator response to mild hypoxemia due to denervation of chemoreceptors). While this information is helpful in deciding on the need for intubation in this patient, it is not the next step. The neurosurgeon should be notified while the patient is examined.

Airway compromise due to an expanding neck hematoma after CEA can lead to death if not promptly addressed. Surgical hemostasis, and emergence free of coughing can help mitigate this complication.

In this patient, the call from the PACU should be followed by immediate examination of the patient and notification of the Neurosurgeon and an ENT surgeon. The patient’s symptoms may be best relieved by opening the wound followed by intubation and emergency reoperation.

Other considerations which may compromise the airway include cranial nerve injuries: CNX can cause complete airway obstruction manifest as stridor (injury to bilateral RLN after bilateral CEA) or hoarseness and potential dysphagia and aspiration from a paralyzed vocal cord if unilateral injury. CNXII (hypoglossal) injury can lead to a paralysis of the tongue causing dysphagia and dysarthria. While stridor may require an emergent tracheostomy in the case of bilateral damage to CNX, other CN injuries may be diagnosed by bedside nasal bronchoscopy.

Herrick I, Arango Mf; Gelb, Ischemic Cerebrovascular disease. In Handbook of Neuroanesthesia, Newfield and Cottrell, eds. 2007, Lippincott, PA


A 30 year old patient with a history of hypertension presents for transphenoidal resection of pituitary tumor. The patient’s voice is hoarse, he has enlarged hands and feet, coarse facial features, and a protuberant jaw. Which of the following is most helpful in predicting difficult intubation in the acromegalic patient?

A. Mallampati Score
B. Thyromental distance
C. Upper lip Bite Test (ULBT)
D. Growth Hormone (GH) levels

Contributed by CA-2, Victor Adimoraegbu, MD  
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In an effort to determine predictors of difficult laryngoscopy in acromegalics, Schmitt et al, examined 128 patients with acromegaly for transphenoidal pituitary resection.

Mallampati scores III (visualization of only base of tongue/uvula) and IV (no structures are seen including soft palate) were helpful in predicting difficult laryngoscopy (Cormack-Lehane Grade III/IV).

- Specificity (% of correctly predicted easy intubations as a percentage of all truly difficult intubations) for Mallampati score III and IV combined was 76%
- Sensitivity (% of correctly predicted difficult intubations as a percentage of truly easy intubations) for Mallampati score III and IV combined was 44%

In an effort to determine predictors of difficult laryngoscopy in acromegalics, Schmitt et al, examined 128 patients with acromegaly for transphenoidal pituitary resection. Laryngoscopy was rated as grade III or difficult (only epiglottis is seen based on Cormack-Lehane grading) in 26% of patients. While the large face of acromegalics may make mask ventilation difficult, thyromental distance defined as the distance from the chin or mentum to the top of the notch of the thyroid cartilage was not significantly different between patients with and without difficult laryngoscopy.

In a study comparing Mallampati score to upper lip bite test (ULBT) for predicting the difficulty of laryngoscopy in acromegalic patients, ULBT failed to predict 73% of difficult laryngoscopies in acromegalics compared to Mallampati scoring (failed to predict 33% of difficult laryngoscopies). The authors suggest that both ULBT and Mallampati score should be used when evaluating the airway of patients with acromegaly.

Sharma D, Prabhakar, H. et al. Predicting difficult laryngoscopy in Acromegaly: a comparison of upper lip bite test with modified mallampati classification. JNA. 22(2): 138-143
In acromegals, macroglossia, prognathism, enlargement of glottic structures, and pharyngeal hypertrophy are contributors to difficult mask ventilation and intubation.

In their group of 128 acromegals, Schmitt et al did not find an association between GH levels and difficult intubation.

Interestingly, in a prospective examination comparing intubation in acromegals compared to patients with non-functioning pituitary tumors, Insulin-like growth factor I (ILGF-1), synthesized from growth hormone (GH) was found to be an independent risk factor for difficult intubation. While GH prompts cell-differentiation, IGF-1 regulates cell cloning and hyperplasia and plays an important role in pharyngeal hypertrophy in patients with acromegaly.

Zhang Y, Guo X. et al. High levels of IGF-1 predict difficult intubation of patients with acromegaly. Endocrine. 2017;57:326-334