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1. A 75 kg, 45 yr-old patient with quadriplegia at C-6 level is scheduled for elective cholecystectomy. Pulmonary function tests show an FVC of 2.4 L and an FEV1 of 1.2 L. Which of the following is the most appropriate conclusion based on these findings?

A. **Intercostal function is normal**
B. **SpO2 will be 80% or less while breathing room air**
C. **Total lung capacity is normal**
D. **The patient has COPD**
E. **These findings are expected in this patient**

Go to Q 2
A. Intercostal function is normal

In patients with a C6 level quadriplegia, intercostal function is unlikely to be normal. Low FEV1 and FVC indicate poor respiratory muscle strength and intercostal function is likely to be impaired. These patients are at risk for postoperative hypoventilation and may have impaired cough and accumulation of secretions.

Ref: Stoelting's Anesthesia and Coexisting Disease. Ch 11; page 259
B. SpO2 will be 80% or less while breathing room air

This is not likely to be true. Hypoxemia is common after acute spinal cord injury when airway intervention is required. This patient coming in for elective surgery is unlikely to have SpO2 of 80% or less.
C. Total lung capacity is normal

The gas volume in the lung after a maximum inspiration is called the total lung capacity (TLC; usually 6 to 8 L). TLC can be increased in COPD either by overexpansion of alveoli or by destruction of the alveolar wall resulting in loss of elastic tissue, as in emphysema. In situations of poor respiratory muscle strength, TLC is reduced. This patient has COPD and quadriplegia and probably does not have a normal total lung capacity.

Incorrect

Try again
D. This patient has COPD

The severity of COPD is classified based on spirometry findings, specifically forced vital capacity (FVC) and FEV$_1$. This patient who has an FEV1/FVC ratio of 1.2L/2.4 L puts the ratio at 50% which is classified as moderate COPD. The overall values are lower for the FEV1 and FVC because of the associated quadriplegia.
E. These findings are expected in this patient

All measurements of pulmonary function that require patient effort will be affected by the strength of the respiratory muscles. Hence in a patient with quadriplegia, the FEV1, FVC, peak flow, MVV would all be decreased. The ratio of FEV1/FVC would still be > 70%. Hence a finding of FEV1/FVC around 50% is not expected and is due to associated COPD.
2. Ms. X was brought to the hospital after collapsing at home. A CT scan revealed a subarachnoid hemorrhage. The following morning, a ventriculostomy was placed to drain CSF. The patient is brought to the OR for coiling the aneurysm. The aneurysm was coiled and the patient needs to be transported back to the ICU. How should you now deal with ventriculostomy system during transport to ICU.

A. **Remove the catheter before transporting the patient**
B. **Keep the transducer in the monitoring position**
C. **Keep the collection chamber below the level of the patient’s head**
D. **Keep the collection chamber above the level of the patient's head**

Go to Q 3
A. Remove the catheter before transporting the patient

Trauma and subarachnoid hemorrhage have become the two classic indications for monitoring of CSF pressure. Monitoring the intracranial pressure and the cerebral perfusion pressure remains an important tool in the management of the patient with a critical neurologic status. Hence one should not remove the catheter.

Indications for intracranial pressure monitoring;
B. Keep the transducer in the monitoring position

For accurate readings, the external ventricular drain system should be zeroed at the jugular foramen projected at the tragus. The transducer should be placed in the monitoring position and patient transported. (see fig).
C. Keep the collection chamber below the level of the patient’s head.

Over drainage of CSF can occur if the patient’s position is changed relative to the transducer (bed height increased) or if the reservoir bag is dropped during transport. Hence it is very important to keep the transducer in the monitoring position so that excess CSF does not get drained by accident. Over drainage has been reported to cause low ICP leading to aneurysm re-bleed subdural hematoma and herniation.

The relationship of ventricular drainage to aneurysmal rebleeding.
Pare L et al. J Neurosurg 1992: 76;422-7
D. Keep the collection chamber above the level of the patient's head

Keeping the collection chamber above the patients head with the transducer open to the patient will not drain CSF against gravity. However, one would not be able to monitor the ICP which could become dangerously high during transport in this critical patient.
3. A 72-yr-old man has had residual hemiparesis since having a cerebrovascular accident three years ago. Compared with the response of the unaffected limbs to non depolarizing muscle relaxants, the hemiparetic limb will show

A. **The same response**
B. **Greater depression of tetanus**
C. **Greater twitch depression**
D. **Less twitch depression**

Go to Q 4
Patients with cervical spine injury frequently undergo multiple surgical procedures requiring general anesthesia and neuromuscular blocking drugs. Quadriplegic patients exhibit altered responses to neuromuscular blocking drugs, whose margin of safety may therefore be reduced. The paretic limb will not produce the same response as the non paretic limb.
B. Greater depression of tetanus

When motor nerves are stimulated at rates of greater than 30 Hz, the twitch responses fuse, and a single sustained contraction of the muscle occurs called tetanic contraction. Most peripheral nerve stimulators are designed to deliver a 50-Hz tetanic stimulus. When there is proliferation of extra-junctional receptors it is likely that the tetanic response will be enhanced not diminished.
C. Greater twitch depression

In patients with paresis of an extremity, the pharmacologic receptor area of the end plate at the neuromuscular junction is hypertrophied and spreads into the muscle as extra-junctional receptors at the neuromuscular junction of denervated muscle. This results in resistance to non-depolarizing neuromuscular blockade in that limb and decreased twitch depression with enhanced train of four ratio in the paretic limb.

D. Less twitch depression

Hemiplegic or quadriplegic patients owing to spinal injuries have altered response to neuromuscular blocking drugs. Moreover, they are dependent on complete recovery of diaphragm and accessory muscles for maintaining adequate respiratory function. Monitoring a paretic limb could result in underestimation of the block and relaxant overdose at the normal muscles. Moorthy and Hilgenberg have reported patients who were extubated based on the TOF ratios monitoring in the paretic limb in patients with residual hemiplegia, required immediate reintubation for respiratory distress. Therefore, it is recommended to monitor neuromuscular response in a healthy limb rather than a paretic limb in patients with hemiplegia or paraplegia.

4. A 50 year old patient presents for transphenoidal pituitary tumor resection. The patient was diagnosed as acromegaly. This is associated with the following except:

A. Increased production of adrenocorticotrophic hormone.
B. Patients could be difficult intubation and ventilation.
C. Patients have an increased risk for diastolic dysfunction.
D. Patients have an increased risk of sleep apnea.
A. Increased production of adrenocorticotropic hormone

Increased production of adrenocorticotropic hormone results in Cushing's syndrome. However, acromegaly results from increased production of growth hormone after the epiphysis have closed and leads to gigantism before the epiphysis have closed. These patients usually present to us for transphenoidal surgery (micro and macroadenomas). Medical therapy is based on GH-lowering drugs (somatostatin receptor agonists) and GH receptor antagonists (pegvisomant). Laboratory tests include growth hormone levels which are not suppressible with exogenous glucose loads and increased insulin like growth factor 1.

B. Patients could be difficult to intubate and ventilate.

Patients have an enlarged jaw (i.e., macrognathia), nose, feet, hands, pharyngeal, and laryngeal tissues (including macroglossia and enlarged epiglottis) making them potentially difficult to intubate and ventilate. A study done predicting difficult laryngoscopy in acromegalics quotes an incidence of difficult laryngoscopy as 24% and difficult intubation as 11%. The authors compared upper lip bite test (ULBT) with modified Mallampati classification to predict difficult laryngoscopy in acromegalic patients. The authors advise using both tests in these patients in order to improve the sensitivity and specificity of detection of a difficult laryngoscopy or intubation.

C. Patients have an increased risk for diastolic dysfunction

The most common feature of acromegalic cardiomyopathy is concentric biventricular hypertrophy. The cardiac hypertrophy of acromegaly mainly occurs in the absence of hypertension, but it can be aggravated by hypertension itself and by abnormalities of glucose metabolism. The initial cardiac hypertrophy, associated with increased systolic output, is followed by diastolic dysfunction and insufficient systolic function on effort. Arrhythmias are present in about 40% of acromegalic subjects: Hypertension, reported in 30–40% of patients, is likely due to increased plasma volume, to decreased ANP levels and to insulin resistance. They have risk factors for myocardial ischemia. Echocardiography and EKG would be prudent on preoperative evaluation.

D. Patients have an increased risk of sleep apnea

Up to 70% of acromegalic patients may have sleep apnea, which places them at increased risk for perioperative airway compromise. The sleep apnea could be central and obstructive and could contribute to the hypertension and diastolic dysfunction.

Lauren K. Dunn and Edward C. Nemergut
Anesthesia for trans-sphenoidal pituitary surgery: Current opinion.
Volume 26; Number 5, October 2013
5. A 60 year old male undergoes coiling of his basilar artery aneurysm under general anesthesia. During the procedure, the patient has an episode of severe bradycardia and extreme hypertension and there is leakage of the contrast from the aneurysm. All the following can be considered except

A. Reversal of administered heparin for the procedure with protamine.
B. Hyperventilation and mannitol administration
C. Placement of ventriculostomy by the surgeon
D. Induction of deliberate hypertension

Go to Q 1
A. Reversal of administered heparin with protamine

As an emergency reversal dose, 1mg protamine can be given for each 100 units of initial heparin dosage that resulted in therapeutic anticoagulation in the last 2 hours, maximum dosage being 50mg of protamine. The activated clotting time can also be used to fine tune the final protamine dose. The administration of protamine can cause hypotension, anaphylaxis and pulmonary hypertension. With the advent of newer direct acting thrombin inhibitors such as bivalirudin new strategies for emergency reversal of anticoagulation need to be developed.

Cotrell’s textbook of neuroanesthesia: ch 14, page 251
B. Hyperventilation and mannitol administration

PaCO₂ should be maintained between 30-35 mmHg, and mannitol (0.25-0.5 g/kg). Hypertonic saline (HTS) may also be given to reduce cerebral edema. The effect of mannitol on brain relaxation is to create an osmotic pressure gradient in intact BBB to move water out of the swollen tissue. It occurs about 30-45 minutes after infusion and judged by the response of the ICP or brain tissue rather than urine output. Hypertonic saline bolus may be administered with goal of serum sodium between 140 and 150 meq/L. Evidence supports rapid infusion of hypertonic saline bolus to reverse transtentorial herniation or decrease ICP. Concentrations > 2% must be given through a central venous catheter.

C. Placement of ventriculostomy by the surgeon

Ventriculostomy catheter provides for drainage of excessive cerebrospinal fluid (CSF) and reduces intracranial pressure. It can also serve as a guidance for blood pressure control and management of cerebral perfusion pressure.

D. Induction of deliberate hypertension

Induction of deliberate hypertension may be protective in situations of cerebral ischemia by increasing collateral blood flow or during vasospasm but may worsen a ruptured leaking aneurysm and would not be indicated. Hence it becomes very important to distinguish between an occlusive and hemorrhagic event in the neurointerventional suite. Aggressive management of a blood pressure surge may predispose patients to the risk of ischemia in areas with a loss of autoregulation. Therefore, it appears best to reserve antihypertensive drugs for patients with an extreme surge of blood pressure as well as clinical evidence of rapidly progressive end-organ deterioration. A practical recommendation is to maintain BP at the same level as that prior to bleeding.