Shunting the CSF

NeuroAnesthesia Quiz # 59

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Question 1: Review of hydrocephalus

Question 2: Locations for distal catheter placement of CSF shunts

Question 3: Treatment of CSF shunt malfunction

Question 4: Risks of CSF shunt placement

Question 5: Risks of surgery for endoscopic third ventriculostomy
Neurological diseases which may require shunt placement include all of the following EXCEPT:

A. Intraventricular Hemorrhage of the newborn
B. Aneurysmal Subarachnoid Hemorrhage
C. Hydrocephalus
D. Arnold Chiari Malformation
This is true. Hydrocephalus (HC) is common after IVH in the premature newborn due to their immature blood vessels. HC occurs due to blood in the ventricular system and decreased CSF reabsorption. Patients with progressive ventriculomegaly despite lumbar punctures will require ventricular shunting. Among low birthweight infants (<1500 g) or <29 wks. gestational age, the incidence of IVH is about 22%.

This is true. Ruptured cerebral aneurysms account for 75-85% of SAH (non-traumatic). HC occurs in 20-30% of patients after a SAH and is associated with a worse neurologic outcome.

External ventricular drain placement (EVD) for hydrocephalus after intracerebral hemorrhage can be lifesaving. The risk of infection of the EVD requires timely determination of the need for permanent ventricular shunt placement. In a retrospective review of >35,000 patients with primary ICH, 6.8% received ventriculostomy. Permanent shunt placement was subsequently required in 7.1% of these patients.

This is not true. Hydrocephalus is not a disease, but a consequence of many disease processes which reflect an imbalance between CSF production and absorption leading to increased CSF volume causing increased ICP. Two types of hydrocephalus are:

- **Communicating hydrocephalus** - flow of CSF is blocked after it exits the ventricles

- **Non-communicating or obstructive hydrocephalus** - flow of CSF is blocked along

The most common cause of congenital hydrocephalus is aqueductal stenosis (infection, hemorrhage or tumor).


This is true. This condition is characterized by various anatomic abnormalities including caudal displacement of the cerebellar tonsils, the cerebellar vermis, 4th ventricle and/or lower brainstem below the Foramen Magnum contributing to non-communicating or obstructive hydrocephalus. Cranial nerve and brainstem dysfunction in these children may cause vocal cord paralysis, stridor, apnea, abnormal swallowing and pulmonary aspiration. Hydrocephalus in these patients is commonly treated with ventricular peritoneal shunt (VPS) and depending on the type of chiari, endoscopic third ventriculostomy (ETV).

Acquired Chiari malformation (tonsillar herniation) has been reported with the use of lumboperitoneal shunts which are typically inserted for communicating HC or pseudotumor cerebri. Incorporation of valves in LPSs to limit over drainage as a contributing factor to this problem has helped to reduce this complication.


The Distal catheter of CSF shunts is placed in all of the following EXCEPT:

A. Pleural cavity
B. Right atrium
C. Peritoneal cavity
D. Lateral ventricle
This is true. A ventriculopleural shunt (VPLS) in which the distal catheter is placed in the pleural cavity provides a good temporary site for diversion of CSF when the peritoneal cavity is contaminated. Other indications include: active inflammation of the peritoneum, adhesions due to past surgery, ascites, peritoneal dialysis, and failure or infection of a prior ventricular peritoneal shunt (VPS). In a case series of 19 patients with VPLS, 2 patients required revision of their VPLS for symptomatic pleural effusion.

This is true. When the peritoneal cavity is suboptimal for a ventriculoperitoneal shunt, the right atrium is another option for placement of the distal catheter. The IJ, EJ or facial vein may be cannulated and the catheter is then fed into the atrium under fluoroscopic guidance. The complication rate for VA shunts is 43% which include: injury to major vessels, shunt nephritis, cardiac thrombi, endocarditis and pulmonary embolism.


This is true. Diverting the CSF to the peritoneal cavity via a VPS is the most common mode of CSF diversion. Obstruction, infection and over drainage are problems which contribute to an overall shunt failure rate in children of 40%-70% at one year. Long term prospective cohort studies have shown that repeated malfunction may lead to impaired cognitive development.


This is not true. The ventricular catheter is typically placed in the lateral ventricle through a burr hole. The risk of intracerebral hemorrhage while rare can be disastrous. A 4% rate of radiographically confirmed hemorrhage (asymptomatic) was identified in one retrospective review of 125 adult patients each scanned within 48 hours of shunt surgery.


A 6 year old Female with a VP shunt for congenital hydrocephalus (aqueductal stenosis) presents to the ED with a Headache, fever (101°F), abdominal pain, nausea, and vomiting. No one else is sick in the home. On exam, she is sleepy. As the intern managing this patient, which of the following would you do next?

A. **Send her home with an appointment to see her neurologist next week**

B. **Admit her to the floor and give her Tylenol for her fever**

C. **Obtain a chest film first**

D. **Obtain a Head CT First**
This is not the next step. This child has evidence of increased ICP (headache, nausea, vomiting, and lethargy) which could indicate possible VP shunt malfunction. Sending this patient home before evaluating her shunt may subject this child to continued increased ICP, herniation, and death.

Data collected in 128 patients with CSF shunts over a 40 year period revealed a 2 year mortality rate in nontumor patients of 12% (16/128) with 2 of these patient’s death due to verifiable acute shunt failure and 2 others from presumed shunt failure.


This is not a next step. This patent may not be a candidate for management on the floor if she truly has increased ICP from VP shunt malfunction. A head CT is advisable. This patient’s fever (101° F), abdominal pain, nausea, vomiting, and sleepiness could indicate a viral/bacterial illness and Tylenol for fever may be appropriate. However, in the case of a shunt infection, the entire shunt system will most likely need to be removed and external ventricular drainage established.


This is not the next step. Evaluation for ventricular shunt malfunction typically includes a head CT followed by a shunt series (X-rays of the skull, neck, chest, and abdomen) if indicated.

Concern for repeated radiation exposure for shunt evaluation in a patient’s lifetime have led to protocols which support head CT first then determine the need for additional imaging. Previous studies suggest that only 15% to 25% of children evaluated radiographically (shunt series) for shunt malfunction in a pediatric ED go on to require surgical revision.

Marchese et al, Presenting to the ED with suspected ventricular shunt complication, Pediatrics. 2017;139(5):e1-e8
Great Job!! **Correct.**

**EXPLANATION**

This is the next step. This child has symptoms of increased ICP making brain imaging to rule out shunt malfunction mandatory. Subsequent imaging of the abdomen for a possible abdominal pseudocyst or other abdominal pathology is also indicated. In the event this shunt is malfunctioning due to infection, this child may need an emergency EVD.

After shunt surgery, infection is the 2nd most common complication occurring at a rate of 3-15% of shunt operations. Risk factors include:

- younger age
- history of prior neurosurgical procedures/shunt revisions
- Presence of a gastrostomy tube

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All of the following are risks of CSF shunt placement EXCEPT:

A. Symptomatic pleural effusion after ventricular-pleural shunt
B. Slit ventricle syndrome
C. Abdominal pseudocyst
D. Hoarseness
This is true. Symptomatic pleural collection of CSF may occur after VPLS placement. Negative intrathoracic pressures during inspiration may be contributory and installation of an antisiphon valve may be helpful in avoiding over drainage another contributory factor.

Two cases of symptomatic pleural effusion which required revision were reported in a series of 19 patients. Other complications in this series included over drainage (2), obstruction (2), retraction (1), and infection (2). Treatment may include thoracentesis, shunt revision, or acetazolamide.

This is true. Slit ventricle syndrome is a condition characterized by over drainage of CSF and occurs in 5-10% of children with CSF shunts. These children do not have enough CSF to compensate for alterations in intracranial volume. Consider this disorder in shunt patients with headache, small ventricles on imaging and slow refilling of their reservoir.

Some treatment modalities which have had some success in patients include: shunt revision, subtemporal decompression, and endoscopic ventriculostomy.


This is true. This fluid collection (CSF) in the peritoneal cavity occurs in 0.7-10% of VP shunt patients (usually children), typically in patients who have had previous abdominal operations and/or multiple shunt revisions or infection. Clinically patients may complain of abdominal pain, nausea, and/or vomiting, anorexia, constipation, fever or signs of shunt malfunction. Pending results of indicated imaging (head CT and usually ultrasound or abdominal CT scan), surgical exploration may also be necessary for 1) adhesiolysis and repositioning of the catheter in the peritoneum, 2) redirecting the distal catheter to the pleura, atrium or gallbladder, 3) aspiration of the cyst and 4) shunt removal and disconnection.

Great Job!! Correct.

EXPLANATION

- This is not true and therefore the correct answer. Endotracheal intubation during general anesthesia for CSF shunt placement contributes to the risk of hoarseness and/or sore throat after this procedure. In the case of ventricular-pleural shunt placement, a double lumen tube is needed for lung separation in order to facilitate the safe placement of the distal shunt catheter in the pleural cavity.

- The incidence of hoarseness occurs in up to 50% of patients after short term intubation. In a prospective evaluation of 56 patients requiring one-lung ventilation, postoperative hoarseness occurred significantly more frequently in patients intubated with a double lumen tube (44%) compared to patients intubated using a smaller ET tube with a bronchial blocker (17%).

- Dexamethasone, lidocaine, and/or lubrication of the double lumen tube may also be helpful in reducing the risk of this post-intubation sequela.


A 7 year old patient presents for Endoscopic Third Ventriculostomy (ETV) for aqueductal stenosis. Intraoperatively during balloon dilatation of the ventricle for CSF drainage, the child’s HR drops to 35. What would you do next?

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<thead>
<tr>
<th>Option</th>
<th>Action</th>
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<tbody>
<tr>
<td>A.</td>
<td>Notify the surgeon</td>
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<tr>
<td>B.</td>
<td>Prepare for urgent craniotomy for hemorrhage</td>
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<tr>
<td>C.</td>
<td>Begin osmotherapy for presumed increased ICP</td>
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<tr>
<td>D.</td>
<td>Administer Epinephrine and/or Atropine</td>
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This is true. Removal of the endoscope and or deflating the balloon by the surgeon will oftentimes resolve this hemodynamic instability. The anesthesiologist should also be prepared to begin treatment with life-saving vasoactive drugs.

ETV involves inserting a fiberoptic endoscope into the lateral ventricle and advancing it into the third ventricle where a stoma is created via balloon catheter dilatation in order to vent CSF into the basal cisterns facilitating flow into the subarachnoid space. Pressure in the floor of the 3rd ventricle from the endoscope, fenestration, and or irrigation can cause significant hemodynamic changes (hypertension, tachycardia or bradycardia, and asystole) due to increases in ICP or decreased perfusion of the medulla compromising the function of the vagal nucleus and parasympathetic preganglionic neurons.

Baykan N, et al Ten years experience with pediatric neuroendoscopic third ventriculostomy features and preoperative complications of 210 cases. JNA. 200;17:33-37
This is not true. Alerting the surgeon to this significant change in HR is critical to determining the etiology and treatment for this bradycardia. The anesthesiologist should be prepared for urgent craniotomy (blood products and vasoactive agents for support) to treat this patient in the event that the surgeon determined an injury occurred to the basilar artery below the third ventricle with consequent hemorrhage and increased ICP.

In a retrospective review of over 200 cases of ETV in children, tachycardia followed by bradycardia were the two more common complications of ETV. One child in this review suffered basilar artery rupture during fenestration necessitating a craniotomy.

Baykan N, et al Ten years experience with pediatric neuroendoscopic third ventriculostomy features and perioperative complications of 210 cases. JNA 2005;17:33-37
This is not true. We do not know if hypertension was a problem in this case, therefore committing to osmotherapy is not indicated before other interventions. Endoscopy and/or irrigation may cause an increase in ICP or pressure on nearby structures like the medulla causing significant hemodynamic changes like bradycardia.

Communication with the surgeon to check for kinking of the outflow line or temporarily stopping irrigation and removing the endoscope in most cases will correct the bradycardia. Emergency vasoactive agents should also be available to treat this patient.


Baykan N, et al Ten years experience with pediatric neuroendoscopic third ventriculostomy features and perioperative complications of 210 cases. JNA. 2005;17:33-37
This is not true. While ETV is considered a minimally invasive procedure, serious life threatening alterations may occur. The anesthesiologist must be prepared to manage sudden changes in hemodynamics. Communication with the surgeon is a mandatory first step. The anesthesiologist will also need to have ready vasoactive agents for treatment of potentially life threatening hemodynamic changes.

Baykan N, et al Ten years experience with pediatric neuroendoscopic third ventriculostomy features and perioperative complications of 210 cases. JNA. 200;17:33-37