CEREBRAL SPINAL FLUID SHUNTS

Surgical Specialty:	Neurosurgery
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Background:

- General Considerations
  - Cerebrospinal fluid (CSF) shunts are used to prevent or treat excess CSF or increased pressure in the cranium. A catheter is placed into the ventricle, allowing drainage of CSF through a pressure-regulated valve and out via a distal catheter. This distal catheter is usually tunneled to the peritoneum (ventriculoperitoneal or VP shunt), but can also be tunneled and shunt CSF into the pleural space or right atrium.
- Patient Considerations
  - Disease Specific Considerations
    - Hydrocephalus may occur due to many etiologies, either congenital or acquired. Congenital hydrocephalus may be due to a neural tube defect such as a Chiari malformation, CNS malformations, congenital syndromes, craniosynostosis, or intrauterine infections. Acquired hydrocephalus may occur due to CNS infections, tumors, or post-hemorrhage.[1]
    - Patients with hydrocephalus may have elevated intracranial pressure (ICP), especially if the onset of hydrocephalus is acute and/or the cranial sutures are closed. Depending on the severity of the elevated ICP, ICP may need to be actively decreased or maintained by preventing further elevations in intracranial volume.
  - Associated Comorbidities/Syndromes
    - Some patients with hydrocephalus, depending on the etiology, may have associated epilepsy. Anti-seizure medications should be continued in the perioperative period.

Anesthetic Planning:

- Pre-Anesthetic Evaluation
  - A standard preoperative evaluation should be performed with special attention to any signs or symptoms of elevated intracranial pressure (altered mental status, lethargy, irritability, nausea/vomiting, bulging fontanelle, downward gaze of the eyes ("setting sun sign"), hypertension, and bradycardia (Cushing response)).
  - Review available Hct levels, coagulation labs, and, in the case of severe lethargy and vomiting, a chemistry panel.

    - Discuss disposition with surgeon/family – monitored bed versus PICU postoperatively.
- Specific or Unique Room Set-Up Requirements
    - Airway
        - Standard or video laryngoscope, appropriately sized ETTs. Prepare for a challenging airway if the patient is macrocephalic or displays syndromic features.
    - Drugs/Infusions
        - Induction medications, acetaminophen, NSAIDs, short-acting opioids, perioperative antibiotics, and antiemetics. Fluids and medications for blood pressure and heart rate support. Continue anti-seizure medication as scheduled.
    - Monitors
        - Standard ASA monitors
        - Arterial line if ICP is severely elevated
        - ICP monitoring, if in place already
    - Blood Availability
        - Type and screen
        - Prepare blood if high risk
    - PICU Bed Availability
        - Varies by institution, PICU versus monitored bed

Intraoperative Considerations:

- General
    - Avoid sudden increases in intracranial pressure (ICP), especially during induction and during tunneling of the shunt catheter. Maintain cerebral perfusion pressure.
    - Peripheral venous access is usually adequate.
    - Pay special attention to temperature management, given the large exposed surface area during the procedure. Consider a forced air warming blanket, warming the room and bed, and warm irrigation.
    - Administer timely perioperative antibiotics. Be aware of any institutional shunt infection prevention protocols.
- Induction
    - Risks/benefits of premedication of an anxious child should be considered. Oversedation can lead to hypoxemia and hypercarbia, thereby elevating ICP, while anxiety and agitation could also raise ICP.
    - Mask induction is generally safe, ideally in a calm, cooperative patient.
    - IV induction may be preferred if ICP is estimated to be very high, but the risks/benefits need to be weighed in a patient without IV access, in whom repeated attempts at placement could be distressing and alter ICP as well.
    - Rapid sequence induction may be indicated if the patient has been vomiting.
    - Endotracheal intubation should be performed with the patient adequately deep and paralyzed.
    - Maintain MAPs in order to maintain appropriate cerebral perfusion pressure.
- Positioning
    - The patient's head should be elevated to 30° if ICP is elevated. Positioning is generally supine with the bed turned 90° and the head turned to the side opposite where the shunt will be placed. Head positioning should not compromise venous drainage. The ETT should be well secured, eyes protected, and all pressure points padded.

- Maintenance
    - Usually with oxygen/air/volatile anesthetic. Consider short-acting opioids. Avoid nitrous oxide due to its effects on ICP.
    - Consider TIVA if ICP is elevated.
    - Ensure the patient is adequately deep with adequate muscle relaxation during the tunneling portion of the surgery.
- Hemodynamic/Physiologic goals
    - Maintain cerebral perfusion pressure (by maintaining MAP and avoiding increases in ICP).
    - Anticipate a sudden increase in the level of stimulation during tunnelling. Consider deepening the anesthetic with volatile agents/propofol/short-acting opioids and ensuring muscle relaxation to avoid sudden movement.
- Surgical Considerations
    - Neuromonitoring is not indicated
    - The risk of significant blood loss is low
    - Maintain cerebral perfusion pressure
- Emergence/Disposition
    - Avoid hypoxemia and hypercarbia during emergence, reverse neuromuscular blockade, and administer analgesics and antiemetics.
    - Depending on institutional protocols for frequent neurologic checks, patients may go to the PICU or a monitored bed after recovery.
- Post-op Care
    - Frequent neurologic checks
    - Analgesia with acetaminophen, NSAIDs if not contraindicated, and small doses of opioids for breakthrough pain

Case Specific Complications/Pitfalls

- MRI safety: Programmable VP shunts have adjustable valves that can be changed non-invasively via a magnet. The settings of a programmable VP shunt can inadvertently be changed by MRI; therefore, the settings *must* be checked after an MRI. This does not need to be done for a non-programmable shunt.
- Potential surgical complications of shunt placement include bleeding, infection, pneumothorax, hemothorax, abdominal perforation, subdural hematoma, and seizures, all of which occur rarely.
- Long-term shunt complications include shunt malfunction, pseudocyst, obstruction, and infection. Shunt revisions are performed to address these complications. In the case of infection, shunt removal, possible external ventricular drain, and later replacement are performed.[3]

References

1. Haridas A, Tomita T. Hydrocephalus in children: Management and prognosis. In: UpToDate, Patterson M and Dashe J (Ed), Wolters Kluwer. (Accessed on November 18, 2024.)
2. Krovvidi H, Flint G, Williams AV. Perioperative management of hydrocephalus. *BJA Educ*. 2018 May;18(5):140-146. PubMed Link
3. Paff M, Alexandru-Abrams D, Muhonen M, Loudon W. Ventriculoperitoneal shunt complications: A review. *Interdisciplinary Neurosurgery* 1018;13:856-862.

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