Cerebrospinal fluid shunt malfunction

- Integration of continuous lumbar drainage and third-generation EGFR-TKI in managing leptomeningeal metastasis-induced life-threatening intracranial hypertension: a case report
- Preventing What Matters: A Fast and Reliable Technique to Secure External Ventricular Drains and Avoid Dislodgement
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- Radionuclide Shunt Scintigraphy Technique in Diagnosing Ventriculoperitoneal Shunt Malfunction and Patency: A Case Study and Review of Literature
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- Cerebrospinal Fluid Shunts to Treat Hydrocephalus and Idiopathic Intracranial Hypertension: Shunt Catheters and Valves

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A cerebrospinal fluid (CSF) shunt is a medical device implanted to manage hydrocephalus by diverting excess CSF from the brain to another part of the body (e.g., peritoneal cavity, pleural space, or right atrium). Shunt malfunction is a common complication and can lead to significant morbidity and, if untreated, mortality.

Types

1. **Mechanical Failure**:

    1. Obstruction of the catheter (proximal or distal).
    1. Disconnection or fracture of the shunt system.
    1. Valve malfunction (e.g., underdrainage or overdrainage).

2. **Infection**:

    1. Most commonly caused by skin flora (e.g., *Staphylococcus epidermidis* or *Staphylococcus aureus*).
    2. Can lead to obstruction or inflammation.

3. **Overdrainage**:

1. Causes subdural hematomas or slit ventricle syndrome.

4. **Underdrainage**:

1. Leads to persistent hydrocephalus symptoms.

5. **Migration or Malpositioning**:

1. Shunt catheter can migrate from its intended location.

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Symptoms of Shunt Malfunction Symptoms depend on the age of the patient and the type of malfunction but typically include: - **Infants**:

1. Bulging fontanelle.
2. Increased head circumference.
3. Irritability or lethargy.
4. Poor feeding or vomiting.

- **Older Children and Adults**:

1. Headache (worsens in lying down position).
2. Nausea and vomiting.
3. Vision changes (e.g., papilledema, diplopia).
4. Gait disturbances.
5. Cognitive decline or changes in behavior.
6. Seizures.

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Diagnosis 1. **Clinical Assessment**:

1. History and physical examination focusing on neurological symptoms.

2. **Imaging**:

1. **CT or MRI**: Evaluate ventricular size.
2. **Shunt series (X-rays)**: Assess mechanical continuity and placement.
3. **Ultrasound** (in infants): Evaluate ventricular dilation.

3. **CSF Analysis**:

1. If infection is suspected, CSF sampling via shunt tap or lumbar puncture is necessary.

4. **Shuntogram or Nuclear Medicine Studies**:

1. Assess flow and patency of the shunt system.

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Management 1. **Immediate Action**:

1. Treat as an emergency if symptoms of increased intracranial pressure (ICP) are present.

2. **Surgical Intervention**:

1. Revision or replacement of the malfunctioning component.
2. Removal of the shunt if infected, followed by external ventricular drainage and antibiotic therapy.

3. **Antibiotics for Infection**:

1. Based on culture and sensitivity.
2. Commonly, vancomycin and ceftriaxone are initiated empirically.

4. **ICP Monitoring and Management**:

1. Use external ventricular drains (EVD) if necessary.

5. **Prevention of Overdrainage**:

1. Adjustable valves or anti-siphon devices.

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Prognosis - Outcomes depend on the promptness of diagnosis and management. - Recurrent malfunction may occur, requiring regular monitoring and follow-up with a neurosurgical team.

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If you need detailed insights on a specific aspect of CSF shunt malfunction, such as surgical techniques, long-term management, or infection prevention, let me know!

Epidemiology

The most recent epidemiological study from the UK Shunt Registry demonstrates that 20% of cerebrospinal fluid shunt malfunction within 1 year of primary insertion, ranging from 31% in infants to 17.4% in adults [1)]

Shunt dysfunction or failure was defined as shunt revision, subsequent endoscopic third ventriculostomy, or shunt infection [2)].

Mechanical shunt obstruction is the most common reason for failure, and in proximal catheter failure, this typically means obstruction by the choroid plexus [3)].

Shunt surgery consumes a large amount of pediatric neurosurgical Healthcare resources. Although many studies have sought to identify risk factors for shunt failure, there is no consensus within the literature on variables that are predictive or protective.

Patients with cerebrospinal fluid shunts frequently present to the emergency department (ED) with suspected shunt malfunction.

Once there is a suspicion of a shunt dysfunction, a CT scan or MRI scan is used to compare the ventricular size and show the most definitive signs of a malfunction. This is only useful if a previous scan can be used for comparison. In cases where the symptoms of a shunt malfunction are present but the scanning shows no evidence, the next step involves a shunt tap test.

Mechanical failure-which is the primary cause of CSF shunt malfunction-is not readily diagnosed, and the specific reasons for mechanical failure are not easily discerned. Prior attempts to measure cerebrospinal fluid flow noninvasively have lacked the ability to either quantitatively or qualitatively obtain data.

To address these needs, a preliminary study evaluates an ultrasonic transit time flow sensor in pediatric and adult patients with external ventricular drainages (EVDs). One goal was to confirm the stated accuracy of the sensor in a clinical setting. A second goal was to observe the sensor's capability to record real-time continuous CSF flow. The final goal was to observe recordings during instances of flow blockage or lack of flow in order to determine the sensor's ability to identify these changes.

A total of 5 pediatric and 11 adult patients who had received EVDs for the treatment of hydrocephalus were studied in a hospital setting. The primary EVD was connected to a secondary study EVD that contained a fluid-filled pressure transducer and an in-line transit time flow sensor. Comparisons were made between the weight of the drainage bag and the flow measured via the sensor in order to confirm its accuracy. Data from the pressure transducer and the flow sensor were recorded continuously at 100 Hz for a period of 24 hours by a data acquisition system, while the hourly CSF flow into the drip chamber was recorded manually. Changes in the patient's neurological status and their time points were noted.

The flow sensor demonstrated a proven accuracy of ± 15% or ± 2 ml/hr. The flow sensor allowed real-time continuous flow waveform data recordings. Dynamic analysis of CSF flow waveforms allowed the calculation of the pressure-volume index. Lastly, the sensor was able to diagnose a blocked catheter and distinguish between the blockage and lack of flow.

The Transonic flow sensor accurately measures CSF output within ± 15% or ± 2 ml/hr, diagnoses the blockage or lack of flow, and records real-time continuous flow data in patients with EVDs. Calculations of a wide variety of diagnostic parameters can be made from the waveform recordings, including resistance and compliance of the ventricular catheters and the compliance of the brain. The sensor's clinical applications may be of particular importance to the noninvasive diagnosis of shunt malfunctions with the development of an implantable device [4)].

Classification

Cerebrospinal fluid shunt malfunction classification.

Ventriculoperitoneal shunt malfunction

see Ventriculoperitoneal shunt malfunction

Diagnosis

Cerebrospinal fluid shunt malfunction diagnosis.

Treatment

Cerebrospinal fluid shunt malfunction treatment.

Outcome

Shunt malfunction outcome.

Case series

Shunt dysfunction case series.

Case reports

Shunt malfunction case reports.

1)
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2)
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3)
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4)
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