Endoscopic Repair of CSF Rhinorrhea

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Overview

• History
• CSF physiology
• Pertinent HPI and PE
• Diagnostic Testing
• Classification
• Treatment
• Conclusion
History

- First repair of CSF leak by Dandy in 1926 using frontal craniotomy. (60-80% success rate)
- 1948 first extracranial approach by Dohlman. (Naso-orbital incision)
- 1952 Hirsch performed transnasal approach
- First endoscopic CSF rhinorrhea repair in 1981 by Wigand. (~90% or better success rate)
  - Less morbidity
  - Standard of care for most cases of CSF rhinorrhea.
Cerebrospinal Fluid

- CSF functions to give physical support and protection to the brain, transport waste products, and to regulate the chemical environment of the brain.
CSF Physiology

- Total Volume of CSF in adult is 90-150 ml.
- CSF is made in the choroid plexus and ependyma at rate of .35 ml/min (500 ml/d)
- Absorbed in arachnoid villi, total volume turned over 3-5 times per day.
Flow rate of CSF

- Flow rates of CSF can be measured using MRI.

Figure 1. Sagittal T1-weighted spin-echo MR image (repetition time msec/echo time msec, 660/20) in healthy 25-year-old male subject shows location (white line) of section acquired at the distal third of, and perpendicular to, the aqueduct of Sylvius for measurement of CSF production rate.
Flow of CSF

- Flows from Lateral ventricle through foramen of Monroe to 3\textsuperscript{rd} ventricle
- Then through aqueduct of sylvius to 4\textsuperscript{th} ventricle
- Next, flows through foramina of Luschka and foramen of Magendie to enter subarachnoid space.
Intracranial Pressure

• Normal ICP is 5 to 15 cm H2O while supine.

• Pressure changes with movement, time of day, cardiac cycle, and respiratory phase.

• Raised during REM sleep, sneezing, laughing and Valsalva.
Disease processes involving CSF

- Hydrocephalus
- Meningitis
- CSF leak
CSF Leaks

- Occur due to dural tears or areas of dural weakness
  - Otorrhea due to temporal bone fractures
  - Rhinorrhea due to anterior or central skull base dural defects
Presenting Symptoms

- Recurrent Meningitis
- Intracranial abscess
- Rhinorrhea, unilateral or bilateral
- Headache
- Obstructing nasal mass
HPI

- Duration of symptoms
- Onset of symptoms
- Associated symptoms
- Severity of rhinorrhea
- Laterality of symptoms
- Quantity and quality of rhinorrhea
Important Questions

• Recent trauma
• History of recurrent meningitis
• Recent sinus surgery, endoscopic surgery, or neurosurgery
• History of hydrocephalus, or increased intracranial pressure
Physical Exam

- Complete otolaryngologic exam
- Cranial nerve testing
- Nasal endoscopy
- Weight and BMI
- Testing for meningeal irritation such as nuchal rigidity, Kernig’s, or Brudzinsky
Findings

- Clear rhinorrhea
- Bony deformity
- Intranasal mass
- Meningeal signs
Differential Diagnosis

- Autonomic dysfunction
- Atrophic Rhinitis
- Allergic Rhinitis
- Sinonasal Polyposis
- Temporal bone fracture with otorrhea
Laboratory Testing

- CSF has a slightly different composition than serum.
- Some proteins are found predominantly in CSF.
  - Beta 2 transferrin
  - Beta trace protein, 2\textsuperscript{nd} most abundant protein found in CSF
Laboratory Testing

• In active rhinorrhea, fluid sample can be collected at initial evaluation.
• With intermittent rhinorrhea, patient may collect sample at home.
• Need at least 0.5ml of fluid.
Beta 2 transferrin

- Produced by neuraminidase activity in the brain, and found only in CSF, perilymph, and aqueous humor
- Electrophoresis used to detect
- Most used laboratory test. 88% specific.
Beta trace protein

• Synthesized in choroid plexus
• Concentration in CSF ~35 fold higher than plasma.
• Quick screening test
• Not useful in patients with renal insufficiency or bacterial meningitis
• Sensitivity 78-100%
• Specificity 86-100%
Imaging

- CT scan
- MRI
CT Scan

- CT scan is essential because of greater bone detail.
- Need high resolution scans, 3.0mm or less cuts.
- Axial with coronal reformats
MRI

- For congenital cases of CSF rhinorrhea.
- Can identify areas of meningocele, or encephaloceles.
- Can identify areas were dura is thinned
Additional Testing

- Intrathecal fluorescein aided nasal endoscopy
- Cisternography, Metrizamide CT cisternography or MR-cisternography
- States of low flow or areas of thinning of dura can be identified
Intrathecal Fluorescein

- 0.5 to 10% (2.5-50mg) fluorescein injected into lumbar space prior to examination.
- Mixed with 10 cc of CSF and slowly injected over 10-20 minutes.
- Nasal endoscopy yellow light filter on the endoscope and blue light filter on the light source
- “Off label” use
IT Fluorescein complications

- Transient pulmonary edema
- Seizure
- Transient numbness in extremities
- Death
- Severe side effects seen with doses of > 500mg
Radioisotope Cisternography

- Radioactive contrast into intrathecal space.
- Pledgets placed in ant. cribriform, middle meatus, and sphenoethmoidal recesses.
- Left in place for several hours
- Detects laterality of defect, but not precise location.
Metrizamide CT Cistern

- Intrathecal contrast injected
- Great for sphenoid or frontal sinus leaks, and assessing meningoencephalocele
- Sensitivity 48-96%
- Complications include:
  - Headache
  - Nausea
  - arachnoiditis
MR Cisternography

- No contrast material needed
- Highlights CSF fistulas.
- Identifies brain parenchyma and CSF in meningoencephaloceles.
- 85-92% sensitivity, and 57-100% specificity.
- Can detect intermittent or low flow leaks.
Classification of CSF Rhinorrhea

- **Etiology** - most important factor for success of surgery.
- **Location** - most important factor for approach
- **Size of defect**
Etiology

- Traumatic – 10-30% of ant. Skull base fractures have associated rhinorrhea.
  - Most common cause
  - Blunt vs. penetrating
- Congenital
  - encephalocele
- Iatrogenic
  - Sinus surgery, transphenoidal hypophysectomy, other neuro. procedures
- Tumor
  - Invasion through skull base
- Spontaneous
  - Usually attributed to increased ICP
Traumatic injury

- Rhinorrhea usually presents within first 48 hours.
- 70% close with conservative intervention
- Those not surgically closed, assoc. with 30-40% risk of ascending meningitis
Iatrogenic

- FESS
  - Lateral lamella of cribriform plate
  - Posterior ethmoid near the roof of the antero-medial wall of sphenoid
- Skull base surgery
- Transphenoidal hypophysectomy
  - Disruption of sellar diaphragm
- Craniofacial resections
Congenital

- Relatively rare
- Present as meningoencephalocele
- Congenital hydrocephalus
- Congenital skull base defect
- Usually have large, funnel-shaped defects
- Normal ICP
Sites of Lesions

• Cribiform plate
• Ethmoid
• Frontal
• Sphenoid
• Multiple
Management

• Conservative
• Open
• Endoscopic
Conservative

- Reserved for blunt trauma with resolving CSF rhinorrhea
- May need lumbar drain
- HOB elevated, no nose blowing, or valsalva
- Acetazolamide to decrease CSF production when raised ICP is suspected
Open Technique

- Reserved for large defects, multiple defects, or defects to lateral sphenoid sinus
- Posterior table of frontal sinus
Endoscopic Technique

- Most causes of CSF rhinorrhea can be managed this way.
- Varying techniques, and graft material
- >90% first time success rate reported in literature
Approaches to Anterior Cranium base

- Paraseptal approach – cribriform plate, eth.
  - with or without sphenoidotommy
- Transethmoidal - sphenoid
  - With or without removal of basal lamella
- Transethmoidal-pterigoidial-sphenoidal
  - Lateral recess of sphenoid
Paraseptal approach
Transethmoidal
Transethmoidal-sphenoidal-terygoidal

- This type of approach was useful for defects located in the lateral wall of the sphenoid sinus. After performing an ethmoido-sphenoidotomy and a wide middle antrostomy it was possible to identify the posterior wall of the maxillary sinus and the pterygoid base. The pterygopalatine artery was then coagulated and it was possible to drill the anterior wall of the sphenoid sinus and the pterygoid base until exposure of the lateral wall of the sphenoid sinus and the floor of middle cranial fossa.
Transethmoidal-pterygoidal-sphenoidal
Graft Material

- Cartilage and mucoperichondrium
- Middle turbinate
- Conchal cartilage
- Abdominal fat
- Mucosa
- Fascia
- Combined
Middle turbinate harvest
Preparation of graft site

• Recipient bed is prepared by removing several mm of mucosa to widely expose the defect.
• Mucosa must be thoroughly removed to increase adherence to site.
• Any encephaloceles must be reduced using bipolar at stalk to prevent intracranial hemorrhage.
Closure Techniques

- Overlay
- Combined
- Obliteration
- Gel foam packing
Post-operative management

- Bedrest
- Stool softeners
- +/- lumbar drain
- Avoid raising ICP
- Repeat endoscopic evaluations
Predictors of success

• Good pre-operative work up
• Technically proficient with sinus surgery
• Adequate exposure of defect
• Choosing optimal procedure based on location
• Normal ICP
Contraindications

• Presence of intracranial lesions
• Comminuted fractures of the cranium base
• Fractures of posterior wall of frontal sinus and lateral extensions of frontal sinus fractures.
Complications

- Meningitis (0.3%)
- Persistent leak (5-10%)
- Pneumocephalus
- Intracranial hemorrhage or hematoma (0.3%)
- Frontal lobe abscess (0.9%)
- Anosmia (0.6%)
- Chronic headache (0.3%)
Conclusions

- Nasal endoscopy
- Beta-2-transferrin, or beta trace protein
- Imaging to localize defect. HRCT for bony defects, MRI for herniations
- Endoscopy provides 90% 1\textsuperscript{st} time success, and up to 97% after 2\textsuperscript{nd} look.
- Patients require close follow-up for resolution of rhinorrhea
Resources