ENDOSCOPIC CSF LEAK REPAIR

DEVIN MISTRY, DO PGY 4
METRO HEALTH HOSPITAL, GRAND RAPIDS, MI
OUTLINE/OBJECTIVES

- Briefly discuss history and pathophysiology
- Discuss classifications
- Discuss diagnosis
- Outline and describe various techniques for repair
  - Nonvascularized
  - Vascularized
- Will not discuss in detail methods for identification or controversies in management
- Will not discuss various etiologies of spontaneous leaks (BIH, congenital, neoplastic)
- Will not discuss etiology and management of otic CSF leak
HISTORY

• 2nd Century AD Galen described CSF leak after cranial trauma
• 1926 Dandy performed first successful repair (originally attempted by Grant in 1923)
  • Closed traumatic tear over frontal sinus with muscle and fascia lata
• 1948 Duhlman describes extracranial repair
• 1950s began using radioisotopes for diagnostics
• 1980s first descriptions of endoscopic repair
PATHOPHYSIOLOGY

- Ultrafiltrate of plasma. Cushions brain. Similar function as that of lymph.
- 50-80% CSF produced by choroid plexus
- 30% produced by ependymal surface
- ~100-150 ml at any given time
- ~500 ml produced a day - replaced 3 times a day
- Produced at 10-20 ml hr
- Normal pressure 7-15 mmHg
- Involves disruption of normal barrier maintained by skull base, dura and arachnoid
EPIDEMIOLOGY

- 80% Traumatic
- 16% iatrogenic
- 3-4% spontaneous
- Often involve basilar skull base fracture (10-30%)
  - May also involve penetrating trauma (9%)
  - May also involve closed head injury (3%)
- 80% involve paranasal sinuses, 20% otic
- Traumatic leaks follow demographics of trauma statistics
  - Majority involve young males 18-25 y.o.
- Spontaneous leaks far more common in females
PRESENTATION

- Symptoms may be intermittent
- Unilateral clear rhinorrhea
  - May be induced by straining, coughing or sneezing
  - May be elicited by leaning forward, dependent positioning
- Salty Taste in the mouth
  - May indicate intranasal source or otic source egressing through the eustachian tube
- Headache
- General Malaise
- Meningitis – rare
CLASSIFICATION

- Various classification schemes
  - By size
  - High pressure vs low pressure
  - Etiology
  - High flow vs. low flow
IATROGENIC

- 16% of CSF leaks
- Most commonly during FESS
  - <1% of FESS cases
- Location
  - Lateral lamella of cribriform 80%
  - Frontal 8%
  - Sphenoid 4% (more common follow nsx – 67%)
- Repair intra-operatively at time of injury
  - Variety of techniques
  - Free-mucosal vs fat vs fascia
TRAUMATIC

- 80% of all CSF leaks
- Most common in young males
- 12-30% basilar skull fractures
- Associated with skull base fractures and facial fractures
- More common in anterior cranial fossa
- May be immediate or delayed
  - 60% present in first few days after incident
  - 70% present in first 7 days
  - 95% present in first 3 months following trauma
    - Delayed presentation due to wound contraction, necrosis of bony edges or soft tissue, resolution of edema, increase in ICP.
SPONTANEOUS

- Associated with numerous etiologies
  - Congenital
  - Neoplastic – tumor erosion
  - Empty Sella Syndrome
  - BIH
    - Increasingly common
    - Most common in obese females
    - Thought to be due to constant pulsations of arachnoid granulation causing ischemic changes and thinning of skull base. Serves as a release valve for increased ICP
DIAGNOSIS

• Traditional halo sign
  • Clearing of CSF surrounding central bloody spot
  • Low specificity - can be produced by tears, saliva etc

• Glucose/Protein levels of samples
  • Poor sensitivity and specificity

• Beta-2-Transferrin
  • Highly sensitive and specific
  • Gold Standard
  • May involve send-out
  • Generally requires > 1 ml sample
LOCALIZATION

- Nasal endoscopy
- HRCT
  - 1-2 mm sections
  - Primary imaging modality
- CT cisternography
  - Intrathecal administration of contrast (methrizamide, iopamidol)
  - Identifies 80% of leaks
  - Poorly sensitive for intermittent leaks
- Intrathecal fluorescein
  - Off label. Not FDA approved
  - Maybe neurotoxic in high doses
  - Low dose (50 mg or less) well tolerated
    - Mix 0.1 ml of 10% fluorescein in 10 ml of CSF. Infuse over 30 min
- Radionuclide cisternogram
- MRI and MRI cisternogram
  - T2 sequencing
  - Distinguish encephalocele
  - CT-MRI fusion for image guidance
LOCALIZATION
LOCALIZATION
TREATMENT - NONSURGICAL

- Conservative management
  - Indicated for initial management of traumatic leaks
  - Best for low flow
- Bedrest
- Elevate HOB
- No lifting, straining, nose blowing
- Stool softeners, cough suppressants
- Lumbar drain? 5-10 ml/hr
- 70-80% CSF rhinorrhea and 95% otorrhea will resolve in 7 days
A NOTE ON CSF DIVERSION

- Lumbar drain
  - Adjunctive treatment for reducing CSF pressure
  - Added risks - 3% Major, 5% Minor complications
    - Meningitis - must monitor CSF cultures
    - Pneumocephalus
    - Overzealous drainage (>15 ml/hr)
    - Hemiation
  - May increase success of repair or conservative management
  - Not recommended for initial management following skull base surgery
    - If leaking, repair has failed → return to OR
TREATMENT - SURGICAL

- **Exposure**
  - Most anterior defects can be addressed endoscopically
  - Posterior table frontal sinus may require Draf III or osteoplastic flap
  - Lateral sphenoid sinus recess may require transmaxillary (pterygomaxillary space or caldwell luc approach)

- **Instrumentation**
  - Angled HD endoscopes – $0^\circ$, $30^\circ$, $45^\circ$, $70^\circ$?
  - Stereotactic Image guidance
  - Extended Colorado Tip Bovie
  - Endoscopic bipolar forceps?
TECHNIQUES - SURGICAL

- **Critical Steps**
  - Identify source
    - Consider intrathecal fluorescein for low flow, intermittent or occult leaks
  - Reduce encephalocoele if present
  - Remove surrounding mucosa and mucosa adherent to dura
    - Remove 0.5 cm
    - Prevents mucocele formation
    - Stimulates osteogenesis
    - Improves graft incorporation
  - Choose graft type
  - Inlay between dura and skull base
  - Onlay graft if significant volume loss (tumor resection)
  - Overlay
  - Fibrin glue
  - Bolster
TECHNIQUES - SURGICAL

High Flow CSF Leak

Defect Site

Sellar/ Transplanar
- Sphenoid Sinus Fat Obliteration
  1. NSF
  2. PCF
  3. TPFF or MFF
  4. PF
- Vascular Tissue Flap
  1. NSF
  2. PCF
  3. TPFF

Transclival
- Small Defect < 1 cm
  - Vascular Tissue Flap
  1. NSF
  2. IF
  3. TPFF
- Fat Obliteration
  1. NSF
  2. PCF
  3. IF
  4. PF
- Large Defect > 1 cm
  - Vascular Tissue Flap
  1. NSF
  2. PCF
  3. IF
  4. PF

Anterior Cranial Fossa
- Bony Ledge
  1. NSF
  2. PCF
  3. IF
  4. PF
- Bony Ledge
  1. NSF
  2. PCF
  3. IF

* Last-line options include AlloDerm, fascia latta, and/or free flap via open approach
**TECHNIQUES - SURGICAL**

- **Graft choice**
  - **Inlay** – variety of choices
    - Dural substitute – durepair, duragen etc.
    - Acellular Tissue Matrix – Alloderm
    - Fascia – Fascia lata, temporalis fascia, pericranium
    - Cartilage – septal cartilage
    - Bone – ethmoid bone, calvarium iliac crest
  - **Inlay should sit between dura and skull base. Held in place by weight of brain**
  - **Onlay**
    - Only critical in cases of significant volume loss and concavity of repair – obliterate dead space for better apposition of overlay edges
    - Typically use fat
TECHNIQUES - SURGICAL

• Overlay
  • Low flow leaks
    • Free mucosal graft
      • Septum, turbinate, side wall
      • Must account for up to 20% shrinkage postoperatively
    • Fascia, periosteum, perichondrium
  • High flow leaks
    • Generally occur in areas of cistern or ventricle
    • Free mucosal graft generally not adequate
      • High incidence of recurrent leak
  • Vascularized flaps
    • Nasoseptal flap
    • Inferior or middle turbinate flap
    • Pericranial flap
    • Temporalis or free tissue transfer
TECHNIQUES – NASOSEPTAL FLAP

• Nasoseptal flap
  • ‘Workhorse’ for skull base reconstruction
  • Pedicled on posterior septal artery (branch of SP)
  • Large enough to cover frontal sinus to sella, orbit to orbit
  • Raised entirely endoscopically
  • Minimal donor site morbidity
  • Risk of septal perforation
  • Enhances on MRI postop
NASOSEPTAL FLAP TIPS

- Equipment
  - Need tip bovie on bovie tip extender. Angle tip
  - Suction catheter in opposite nare in NP for smoke
- Not used to endoscopic septoplasty?
  - Start open, convert to endoscopic
- Make superior cut last
- Rents/perfs don’t matter
  - Rosen et al. 0% leak rate with small tears
- Preserve olfactory mucosa
- Remove face of sphenoid posterior to pedicle
  - Increase arc of rotation, reach of flap
- NSF may be reused, replaced and recycled
TECHNIQUES – INFERIOR TURBINATE FLAP

- Mucoperiosteal flap of inf turb
- Based on branch of SP.
  - Can be anteriorly or posteriorly based
- Technically challenging
  - Must filet open turb or remove bone
  - Risk damage to NLD
  - Smaller surface area
  - Best for defects of clivus and sella
  - Does not reach anterior cranial fossa
  - May be expanded to include anterior lateral wall
TECHNIQUES – INFERIOR TURBINATE FLAP
TECHNIQUES – INFERIOR TURBINATE FLAP
TECHNIQUES – MIDDLE TURBINATE FLAP

• Similar technique to Inf Turb Flap
• Smaller surface area
• Can be raised locally for fovea/ethmoid defects
• Pedicle is posteriorly based, can be easily compromised when incising.
• Thin mucosa
• Reach sphenoid, anterior fossa
• May limit harvest to medial or lateral aspect
• Risk creation of secondary CSF leak during harvest
TECHNIQUES – PERICRANIAL FLAP

• Extremely large surface area
• Harvested endoscopically or bicoronally
  • Based on deep branches of supraorbital and surpatrocheal arteries
  • Harvested unilaterally or bilaterally
  • Low donor site morbidity
• Must be tunneled through small window in nasion
  • Mandates draf III to create drainage pathway around flap and avoidance of mucocele
TECHNIQUES - PERICRANIAL FLAP
OTHER OPTIONS

- Dermal substitutes
  - Alloderm ideal in anterior fossa
  - Must have bony ledges for inlay
- Contralateral Nasoseptal Flap
- Tunneled extracranial
  - Occipital
  - Facial artery buccinator
  - Temporoparietal
  - Palatal – theoretical. Difficult harvest. Donor site morbidity
- Free tissue transfer
  - Tunneled RFFF
Placement and Post-Op

- Placement of flap can be cumbersome
  - Three handed technique expedites procedure
- Hold edges in place with Surgicel
- Once placed, cover with tissue glue
- Bolster repair
  - Merocels
  - Nasopore
  - Foley
- Cover bolster with gel foam
- Remove POD 5
- Evaluate flap by enhancement on MRI
- Follow pneumocephalus
- Wait to begin nasal irrigations
- Sign of leak → return to OR
PLACEMENT AND POST-OP
THANK YOU
REFERENCES

- http://www.thebarrow.org/Education_And_Resources/Barrow_Quarterly/205259
- Craig S. Murakami, MD; J. David Kriet, MD; Alexander P. Ierokomos, MD. Nasal Reconstruction Using the Inferior Turbinate Mucosal Flap. ARCH FACIAL PLAST SURG/VOL 1, APR-JUNE 1999