CSF RHINORRHOEA

Introduction

- Symptom of failed containment of CSF to its subarachnoid compartment
- Due to a CSF pressure gradient that is either continuously or intermittently greater than healing tensile strength of disrupted tissue
- Leakage of CSF from the sub–arachnoid space into the nasal cavity due to defect in
  - Dura
  - Bone
  - And mucosa

Pathophysiology

- CSF from choroid plexus circulates absorbed from arachnoid villi
- Produced @ 20ml/hr in adults
- Total CSF volume 140 ml
- CSF pressure 40 mm H₂O in infants, 140 mm H₂O in adults
- Fluctuates with respiration, head position
- Maintained by balance between secretion and resorption

- Traumatic causes :
  - Creation of defect leak Pressure gradient higher then healing tensile strength
- Nontraumatic causes
  - Postulated mechanisms
    - Raised ICT
    - Rupture of arachnoid sleeves passing with olfactory nerve
    - Empty Sella Syndrome(ESS)
      - Normally sella turcica filled with pituitary
      - Dura herniates through sellar diaphragm this can compress pitutary gland and lead to ESS
    - Ommaya’s theory of focal atrophy (Ommaya 1964)
      - Cribriform plate, sella-turcica area become thin-- due to ischemia
      - Pouch filled with CSF- normal rise in pressure further erosive effects—cranial vault excavation
• Origin from cranial fosse and routes

- Ant cranial fossa → Frontal/ Sphenoidal/ Ethmoidal Sinus / Cribiform Plate → Nose
- Middle & Post. Cranial fossa → Mastoid Air Cells/ Middle Ear → Eustachian Tube → Nose
- Middle cranial fossa → Sphenoid Sinus → Nose

AETIOLOGY

Modified Ommaya’s Classification

• Traumatic
  a) Accidental
     i) Immediate
        (1) Skull base fractures
        (2) Open or penetrating injuries
        (3) Post-traumatic hydrocephalus
     ii) Delayed – within 3 months
         -- Explanation
             • Initially oedema obstructs → later resolves → leak
             • Fracture haematoma → resolves
  b) Surgical
     i) Complication of neurosurgical procedures
        (1) Trans sphenoidal hypophysectomy
(2) Frontal craniotomy
(3) Other skull base procedures

ii) Complication of rhinologic procedures
(1) Sinus surgery
(2) Septoplasty
(3) Other combined skull base procedures

- Non traumatic
  a) Elevated intracranial pressure
     i) Intracranial neoplasm
     ii) Hydrocephalus
        (1) Noncommunicating
        (2) Obstructive
     iii) Benign intracranial hypertension
  b) Normal intracranial pressure
     i) Congenital anomaly
        (1) Meningocele
        (2) Meningoencephalocele
        (3) Congenital skull base defects
        (4) Congenital hydrocephalus
     ii) Skull base neoplasm
        (1) Nasopharyngeal carcinoma
        (2) Sinonasal malignancy
     iii) Skull base erosive process
        (1) Sinus mucocele
        (2) Polypoid disease
        (3) Cystic fibrosis
        (4) Fungal sinusitis
        (5) Osteomyelitis
     iv) Idiopathic

- Percentages of important causes
  o Traumatic - 80%
  o Surgery - 10%
  o Inflammations / tumors - 6%
  o Idiopathic - 4%

- Most common surgical causes
  o Headlight intranasal surgery
  o Endoscopic sinus surgery
Dr. Supreet Singh Nayyar, AFMC 2011

- Craniotomy
- Transsphenoidal hypophysextomy

**Incidence of CSF leaks in FESS 0 to 2.5 %**

**Sites Prone for Injury in FESS**
- Lateral Lamella of Cribriform plate
- Junction between middle turbinate and roof of the ethmoid sinus—bone becomes thin & slopes
- Roof of ethmoid is higher than cribriform plate
- Area of cribriform plate-perforated bone/adherent dura
- Lateral cribriform plate in the region of anterior ethmoid artery-- least resistance
- Violation of rostrum of sphenoid— if anterior sphenoid not identified

**Classification of trauma to the Skull base**
- **Type I:** involves only the anterior wall of the frontal sinus.
- **Type II:** Involves the face and extend upward to the skull base along with type I
- **Type III:** involves frontal part of the skull and extend down to the cranial base.
- **Type IV:** combination of types II and III.
- **Type V:** involves only ethmoid or sphenoid bones

**History**
- Unilateral watery nasal discharge can be B/L
- Cannot be sniffed back
- Salty taste
- ↑ on bending forward
- ↑ on Valsalva
- h/o Maxillofacial trauma, sinus surgery
- Watery rhinorrhoea considered CSF untill otherwise proven
- H/o transient increase in ICT e.g. Nose blowing, sneezing
- H/o hyposmia/anosmia—cribriform plate damage
- Detailed history of nasal and sinus health - May mimic symptoms of CSF leak
- Headache
  - Relieved by rhinorrhoea– high pressure leak
  - Benign Intracranial Hypertension
  - Empty Sella Syndrome
  - Neoplasm
  - Repeated meningitis
History specific of neoplasm
- Ear symptoms if CSF otorhinorrhea

Examination
- U/l watery rhinorrhoea on leaning forward
- Queckenstedt Test: compression of both IJV → ↑ rhinorrhoea
- Halo sign/Double ring sign
  - Done when rhinorrhoea associated with blood
  - Clear ring surrounds a central bloody spot
  - Generally post trauma discharge is dropped on handkerchief/paper towel
  - False negative – tear / saliva
- Handkerchief test
  - Fluid associated with rhinitis contains mucus and so stiffens the cloth while CSF doesn’t
- Nasal examination
  - Anterior rhinoscopy
    - Nasal condition
    - Clear fluid / blood stained fluid
- Nasal endoscopy
  - May identify the site of the leak in 36% (Marshall et al)
  - May identify the cause, such as an encephalocele
- Nasal endoscopy with intra thecal fluoresin
  - Pre op / intra op
  - Stream of clear/coloured fluid
- Reservoir sign
  - Supine for some time---brought to upright with neck flexed---rush of clear fluid
- Features of raised ICT

Biochemical Tests
- Estimation of Glucose
  - Simultaneous blood sample
  - CSF glucose is 1/3rd of blood (> 30 gm/dl)
- Glucose Oxidase Test:
  - Suspected nasal discharge --Glucose oxidase strips
  - Glucose present -- Colour change — suggestive of CSF
Reliability:
- Test Invalid if -- Contamination with blood
- High false positive
  - Reducing substances in tear & nasal mucus
  - Airway secretions in diabetes/ stress/ inflamed epithelial due to viral colds
- False negative
  - Active bacterial meningitis glucose reduced

β 2 transferrin (Gold Std)
- Produced in the brain
- Present in CSF, perilymph, and ocular aqueous humor
- Not in serum, sinonasal mucous secretions and tears
- Sensitivity 100%
- Specificity 95%
- Only a few drops of CSF (0.5 ml)
- Immuno-electrophoresis—cellulane acetate strip—contains anti transferrin serum—CSF will stain both B1 and B2 area
- False positives
  - Conditions that cause abnormal transferrin metabolism and
  - Thus the beta-2 form can appear in the blood
    - Chronic liver disease
    - Inborn errors of glycogen metabolism
    - Genetic variant forms of transferrin
    - Neuropsychiatric disease
    - Rectal carcinoma
  - Recommended taking a simultaneous blood sample to exclude this possible source of error
  - Transportation may degrade the sample
  - If possible, centrifuge & transport frozen

Investigation
- HRCT axial and coronal (1-2mm slice)—84% detection
  - Traumatic - Fracture, fistula & pneumocephalus
  - Non traumatic- To exclude tumor, hydrocephalus
  - Coronal: Cribiform plate, fovea ethmoidalis, floor of frontal sinus, pitutary fossa, orbit roof, sinuses
  - Axial: Ant and posterior tables of frontal & sphenoid sinus, ethmoid plate
  - Level of roof of nose– identified correctly
CT Cisternography
- Most useful and reliable to localize
- Procedure:
  - 5-7 ml contrast medium into the lumbar subarachnoid space.
  - Metrizamide/ iohexol used
- Patient kept prone
- Coronal images (2-3 mm) through the face and cranium, including all of the PNS and the mastoid air cells.
- ICT may be raised by valsalva, intra-theecal saline , alternatively raising the foot end
- Look for:
  - Contrast through bony defect
  - Extra-cranial dye adjacent to bony defect
- Fallen from favour
  - Invasive, time consuming
  - Headache, nausea, vomiting, seizures
  - No use in inactive leak
  - Relatively contraindicated in
    - Active meningitis
    - Raised intracranial pressure

MR Cisternography
- Technique - T2 weighted with fat suppression
- MR criteria for locating CSF leakage
  - Bright signal of CSF
  - Different from inflammatory paranasal secretion
  - A CSF column communicating from the subarachnoid space extracranially
  - Herniation of brain tissue / meninges extracranially
- Advantages
  - MRI is advisable in case of encephaloceles to delineate the contents and vascularity of the sac before surgical exploration
  - Noninvasive
  - Does not involve the use of contrast
  - It detects CSF fistula by inherent bright signal
  - 80% sensitivity (Scott Brown)

Intra-Thecal Dyes
- Pre / intra operatively
- 0.25mL of 5 % fluorescein mixed with 10 mL of CSF from a routine lumbar
puncture
- Mixture is introduced via a polymedic pencil point spinal needle
- Patient placed in trendelenberg position for approx 1 hr
- Nasal endoscopic exam
- If positive, fluorescein seen coming from defect
- Use of a blue filter on endoscope light source - increase detection
- If, at operation, fluorescein not seen → anaesthetist can temporarily raise the intracranial pressure
- Complications described but with higher conc.
  - Knee and ankle clonus
  - Seizures, opisthotonous
  - Cranial nerve defect

- Radionucleide cisternography
  - Radioactive I 131, Serum albumin, Tc 99/ Indium111 labelled DTPA
  - Intrathecal administration– monitoring by scintillation camera
  - Intranasal pledgets placed and then 12-24 hrs later traced with gamma camera.
  - ORNC(Over pressure radionucleide cisternography)
  - Constant tracer infusion to increase flow
  - 80% leak can be detected

**MANAGEMENT**

- Medical / Conservative
  - Majority of acute traumatic fistula heal spontaneously
  - Trial of conservative management be considered for 10-14 days
  - Goal - to reduce CSF leak flow by decompressing the ICP → in this way, healing at the defect site may seal the leak → healing by primary intention
  - Includes
    - Strict bed rest with head elevation
    - Stool softners (isabgol, Liquid paraffin)
    - Avoid coughing, sneezing, nose blowing, straining
    - Medicines to reduce spinal fluid e.g. acetazolamide, frusemide
    - CSF removal
      - Serial tapping / Indwelling lumbar drain (5-10 ml/hr)
      - Subarachnoid drainage through a lumbar catheter
      - Although lumbar drains are passive devices, they require aggressive management
        - Daily CSF cell counts, protein, glucose, and cultures
• Complications
  o Severe headache
  o Pneumocephalus
  o Meningitis
  ▪ If treatment fails after 10-14 day or leak recurs – Surgical Closure
  ▪ Role of prophylactic antibiotics
    • Controversial
    • May induce resistance in likely pathogens
    • Reasonable to administer antibiotics in those patients with a history of suppurative bacterial sinusitis (Cummings)

• Surgical
  o Indication
    ▪ Failed conservative treatment
    ▪ Open wounds
    ▪ Intracranial hemorrhage
    ▪ Recurrent meningitis
    ▪ Complication identified during Endoscopic surgery
  o Treat associated facial fractures
  o Options
    ▪ Endoscopic surgery
      • Method of choice for majority of CSF leaks
    ▪ Intra-cranial/Trans-cranial approach
      • In co-existing intracranial pathology requiring excision
      • Reserved for those that fail or persist despite extra-cranial repair attempts
    ▪ Extra-cranial approach
      • Method of choice in leaks from posterior wall of the frontal sinus
  
• Endoscopic Approach
  o Advantages
    ▪ Faster
    ▪ Less morbidity
    ▪ Precise visualisation of the defect
    ▪ Extended visualization with angled telescopes
    ▪ Accurate placement of the graft
    ▪ No brain retraction
- Tissue sparing dissection
- Frontal & Sphenoid sinus reached
- Sense of smell preserved
- Avoids an external incision,
- Excellent results 90%

  - Graft - Underlay and/or onlay grafting
    - Composite graft
      - E.g. Muscle, fat, fascia, cartilage, tissue glue
      - Fascia lata with fat obliteration of the sphenoid
      - Middle turbinate flap and dural patch
    - **Bath plug technique** - ear fat ('bath plug')
    - Pedicled flaps (Turbinates / septal mucosa)

  - Technique
    - Localization of defect- Graft prepared--Freshening of margins
    - Preparation of the recipient bed
      - Removal of surrounding mucosa
        - Exocrine glands in mucosa secrete and separate graft
      - Abrading the bed with burr/ curette
        - To stimulate osteoneogenesis
    - Placement of Graft
      - Underlay: ethmoid roof, posterior wall of frontal sinus
      - Onlay: sphenoid, cribiform plate
    - Soft tissue alone if defect <10 mm
    - Cartilage / bone with soft tissue if > 10mm
    - Tobacco Pouch Technique: circular piece of graft folded, filled with fibrin sponge/fat- placed on defect with glue
    - Bath Plug Technique – prolene thread passed through fat, placed in defect, thread pulled, forms plug
    - Nasal Pack
    - Post Op Care

  - Unsuitability
    - If we cannot visualize the entire defect
    - Lateral defects in the sphenoid sinus
    - Defect not demonstrable by Imaging / Fluorescein test / Nasal endoscopy
    - Very large / Failed repairs
    - Posterior wall of frontal sinus
- Complications
  - Recurrence
  - Meningism
  - Olfactory disturbances
  - Meningitis
  - Conversion to open procedure (due to bleeding)
  - Donor site infection
- Factors Contributing to Failure of Endoscopic Skull Base Repair
  - Inability to localize Skull Base defect
  - Development of new Skull Base defect
  - Prior sinus or Skull Base surgery
  - Prior craniotomy
  - Prior radiation therapy
  - Intracranial infection
- Most series point to >90% success rates

- Intracranial Techniques
  - Principle:
    - Craniotomy → defect site identified → sealed
  - Cribiform plate → Frontal craniotomy
  - Rarely middle fossa/ posterior fossa craniotomy is required for leaks from those areas
  - Sphenoid sinus → Extended craniotomy
  - Grafts:
    - Fascia lata, muscle plugs, pedicle periosteal flaps
    - Fibrin glue use to hold the graft
  - Advantages
    - Direct visualization,
    - Repair and inspection of adjacent cortex
  - Drawbacks
    - Cerebral edema, hematoma, seizures, frontal lobe
    - Increased morbidity
    - Extended operative time
    - Prolonged hospitalization
    - Anosmia
    - High incidence of persistent leak (20%-40% failure rate)
    - 10% have persistent leaks despite multiple repair
• Extra-cranial Approach
  o Approaches
    ▪ External ethmoidectomy for access to the cribriform plate
    ▪ Transmastoid for tegmen defects
    ▪ Trans-septo-sphenoidal
    ▪ Coronal/eyebrow incision to frontal sinus with osteoplastic flap
  o Methods to close defect
    ▪ Frontal & sphenoid sinus — mucosa removed — sinus obliterated with fat
  o Cribriform and roof of Ethmoid
    ▪ Most commonly involved in traumatic leaks.
    ▪ External ethmoidectomy approach
    ▪ Ethmoid labyrinth entered by perforating lacrimal bone and lamina papyracea
    ▪ Complete ethmoidectomy - cribriform - dural defect is exposed
    ▪ Mucoperiosteal flap to repair the fistula— nasal septum/middle turbinate
    ▪ Free fascial graft from temporalis fascia / tensor fascia lata to reinforce
    ▪ Gelfoam and nasal packing
  o Advantage
    ▪ Decreased morbidity,
    ▪ Superior exposure of the sphenoid, parasellar, and posterior ethmoid regions.
    ▪ Success rates from 80%-90%.
  o Limitations:
    ▪ Inability to examine the underlying cortex
    ▪ Lack of success with repairing high-pressure leaks
    ▪ Patients with raised ICT may need CSF shunting
  o Complications:
    ▪ Facial numbness
    ▪ Septal perforation
    ▪ Orbital complication

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